THE

JOURNAL

OF

SCIENCE AND THE ARTS.

EDITED AT THE ROYAL INSTITUTION
OF GREAT BRITAIN.

PUBLISHED QUARTERLY.

VOL. VI.

LONDON:

PRINTED FOR JOHN MURRAY, ALBEMARLE-STREET,
BY W. BULMER AND CO. CLEVELAND-ROW, ST. JAMES'S.

1819.

CONTENTS

TO

No. XI.

CONTENTS.

CONTENTS.

CONTENTS

OF

No. XII.

CONTENTS.

TO CORRESPONDENTS.

The letter of *Philo-Chemicus* on *Theoretical Analysis,* is not inserted, as we have already fully expressed our opinion of the mischievous tendency of substituting theory for facts. We shall, however, most willingly give place to any experimental illustrations with which he may be kind enough to furnish us.

If the interesting facts contained in the paper on Platina may be parted from the *atomical* observations, they shall appear in our next Number. Certainly the *whole* cannot be published *anonymously.*

New editions of the Numbers of this Journal which were out of print, may now be had at Mr. Murray's; also complete sets of the six volumes, either bound or in boards.

The Editors are again under the necessity of requesting their Correspondents to be a little earlier in their Communications: as all materials are ultimately consigned to the Printer *fourteen days* before the Number appears.

The Notes illustrating Mr. Cockerell's Plates on the Ægina Marbles will be given in No. XIII.

THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS

Art. I. *On the periodical Suspension and Renewal of Function observable in the Human Body.* By J. R. Park, M. D. F. L. S. & M. R. I.

On the Cause of Hunger.

In the six preceding essays, on the subject of the animal economy, the leading object has been the establishment of general principles in physiological science; the want of which is the acknowledged cause of the uncertainty and confusion that prevail in medical reasoning.

The knowledge, however, of general principles, is not alone sufficient for the explanation of natural phenomena. Every function in the animal system is more or less complex in its nature; the influence of one principle is often modified, and sometimes counteracted by that of another; hence, difficulties arise in explaining particular results, which are not to be overcome without taking into consideration the countervailing influence of different principles, and without an intimate acquaintance with the several corollaries arising out of each.

Among the general laws of motion, deduced from the phenomena of life, the first regarded the limitation of power in moving organs; producing a periodical intermission or fluctuation of function, by rendering indispensible an alternate change of action and rest.

This alternation has been considered by Bichât, and former

physiologists, as exclusively confined to the organs of animal life, or to those of voluntary motion and mind. But the grounds of this inference, whether founded on reasoning, or derived from experiment, were shewn to be alike inconclusive; and facts were adduced that sufficiently establish a perfect analogy between the two classes of moving fibres; motion being effected by similar means, and subject to the same general laws, both in animal and automatic functions; requiring, and at certain periods receiving in both, that renewal of activity which results from a state of partial relaxation or rest.

Upon the analogy that subsists between voluntary and involuntary motion, or the identity of the means employed in the production of both, rests, as formerly suggested, the solution of some of the most interesting problems in physiological science; amongst which are the periodical returns of hunger or thirst, and satiety, and the alternate suspension and renewal of activity in the mental powers in sleep and waking.

The nature of this analogy is not, however, elucidated by merely applying to one class of organs, the terms familiar, by their application to the other, such as fatigue and relaxation, action and rest; but requires a minute examination of the circumstances under which the corresponding changes take place in each class of functions. It is in this way alone that the parallel between them can be fairly traced out; and that a definite idea of these different modifications of the moving power can be obtained.

The term fatigue, in its common acceptation, is too indefinite to indicate the changes that occur even in voluntary motion, being indifferently applied to the state of painful exertion in all its gradations, and likewise to the total suspension of power apt to ensue after long continued exertion. These changes, though proceeding from the same cause operating in various degrees, are yet, as to their immediate effects, materially different; and their real nature is not likely to derive illustration from terms, ambiguous, even when applied to the more obvious phenomena they were originally intended to describe, and still more ambiguous when transferred to

phenomena so far removed from the sphere of observation, as the fluctuations of power which occur in the internal organs

To trace out the parallel between the changes occurring in the organs of locomotion, and those incidental to the organs of digestion, is the subject proposed for immediate consideration.

The insufficiency of any of the explanations of the physical cause of hunger, hitherto given, is generally admitted.

Some ascribe this sensation to the emptiness and consequent collapse of the sides of the stomach. But why then should collapse be painful in this organ, more than in others, as the bladder and rectum, which experience no painful sensation when collapsed or emptied?

By some, it is ascribed to attrition of the sides of the organ against each other, when its contents are evacuated. But this supposition is irreconcileable with the acknowledged fact—that hunger often arises before the stomach is half empty, as in cases of indigestion.

Another cause more generally assigned for the sense of hunger, is the supposed power of the gastric fluid to erode or dissolve the coats of the stomach. But if any organ could be imagined in the healthy state to secrete a fluid to erode itself, what suspends its action, when hunger spontaneously ceases after fasting longer than usual? or, how could any one fast for four and twenty hours with impunity?

But it is needless to dwell on these erroneous theories, since the best refutation of them, is the substitution of a true one.

As the explanation of this phenomenon about to be proposed, rests upon the similarity of the laws governing voluntary and involuntary motion; it is necessary to its elucidation, to take a retrospective view of the general laws of muscular action.

The fluctuations of power and activity attendant upon bodily exertion are sufficiently evident; and though somewhat diversified in different individuals, are observed to hold nearly the same general tenour. being characterized by the occurrence of a series of changes or successive stages of action.

They commence, as formerly noticed, with a state of comparatively inefficient activity; but the mobility increasing as

exertion continues, the power of action, in a short time, arrives at the highest degree of muscular energy; this, after a certain period, is followed by a further change; the mobility becomes excessive, and disposes to spasm, causing the state of painful exertion called fatigue.

These successive changes have, for the sake of perspicuity, been distinguished into three stages of action, viz the stage of feebleness or incipient activity; that of energy, or fullest activity without pain; and lastly, that of extreme or painful activity; but still the transition from one to another does not admit of accurate delineation, as all these changes proceed from the same cause gradually increasing in force. And, finally, the loss or suspension of power ensuing after long continued exertion, was also shewn to arise from a farther increase of the same change, causing a spastic rigidity, which affects both flexor and extensor muscles, and thus renders the limb for a time fixed and immoveable.

The reason of these variations in the moving power, which has long been an object of investigation, was shewn to be, not the accumulation or expenditure of nervous energy, as commonly alleged, but an augmention of mobility resulting from an altered condition of the muscle itself, which appears to be essential to muscular action, and subjects all moving organs to similar stages.

This change of condition is not hypothetically assumed; like the exhaustion of nervous influence, but visibly appears in the part, and is practically demonstrated to exist by the remedies often required for its removal. It is a change in the capillary circulation, which produces in the moving organ a corresponding variation of power; mobility increasing like sensibility and every other function as circulation becomes fuller and quicker, and declining as circulation is retarded or diminished.

This connection between the powers of action and the state of circulation is seen in the influence of cold, which diminishes mobility in the same degree that it impedes circulation; in the effect of warmth, which restores the power of action, while it renews circulation; in the efficacy of friction applied to the

limbs under the spasmodic state produced by over fatigue, or in the influence of cordials taken into the stomach at the same period, which restores active circulation, and thereby revives the mobility when apparently exhausted.

Now it appears, in these instances, a fair induction to regard the fluctuations in the moving power, as the consequence of altered circulation; since the same effects uniformly attend the same changes of circulation, whenever they occur, and from whatever cause they proceed.

But the proofs of this general law having been formerly given, need not be repeated, further than is required for elucidating the nature of these changes that accompany the progressive stages of action.

At the commencement of action in the healthy state, the circulation is tranquil, and is not instantaneously augmented, but gradually rises with exertion; and along with this increase is experienced an augmentation of mobility. During the next period, or that of energetic action, the activity of circulation also reaches its maximum. At length, as the mobility becomes excessive, disposing to spasm, and the stage of fatigue approaches, the circulation likewise becomes inordinate; as seen in the irregular distribution of the blood, and the appearance of partial congestions. If exertion be continued to the last extremity, till the powers of action are suspended and the limbs become rigid from spasm; a transition may then be seen to have taken place from a state of active to one of impeded circulation; the temperature of the limb is lowered; it feels cold and benumbed; its capillary vessels, in short, present the same appearance of spastic constriction that affects the muscles.

It is in this state that friction applied to the limbs, and cordials taken into the stomach, or immersion in the warm bath, by relaxing these vessels renew circulation, and restore the powers of action.

But without these means, in ordinary cases, the spastic rigidity gradually subsides during rest, and the organ returns to the healthy state. When exertion, however, has been so long continued as to bring on a morbid change in the organs,

the succeeding relaxation will then be excessive, like the previous constriction: and the consequent weakness and overdistention of vessels, constituting a state of sub-inflammation will be attended with a painful increase of mobility in the muscle, and a tendency to spasm. This state often requires the local application of leeches or cupping, to unload and relieve the distended vessels; means which bespeak the nature of the change while they effect its removal.

Thus the fluctuations of power which constitute the successive stages of action are connected with corresponding changes of circulation in the moving organ; and between circulation and muscular action a reciprocal influence appears; action increasing circulation, while increased circulation augments the power of action.

But, since motion is effected, as before shewn, by similar means in all moving organs; so all should be subject to the same changes in a degree more or less conspicuous; and accordingly sufficient evidence may be found, that the same progressive stages are attendant upon continued exertion in all moving organs, and are connected in all with similar changes of circulation.

The importance of attending to them, and the relation they bear to the state of activity, is no where more conspicuous than in the stomach, which has a two-fold function to perform; being not only the organ of digestion, but likewise destined to the purpose of secretion, a process wholly vascular.

Upon this will be seen to depend the connection between hunger and its attendant phenomenon thirst; hunger proceeding from a certain condition of the muscular fibre, while thirst arises from a peculiar state of the secreting membrane; both depending upon change of circulation, and therefore intimately connected with each other.

This connection will be further noticed hereafter. The subject that first demands consideration is, the action of the stomach, as an organ of digestion; and the analogy between its successive changes, and the stages of action already pointed out in the organs of voluntary motion.

One point of difference it is important to keep in view, that

prevails between voluntary and involuntary organs, resulting, as formerly noticed, from the intimacy of their respective connection with the sensorium; and this is, that in parts immediately under cerebral influence, the continuance of action may at any time be suspended, and the stage of painful exertion be prevented from occurring; whereas parts not subject to the will, are exempt from such interruption, and pass regularly through the successive stages of action. If, towards the close of this period they be not disposed to relaxation by extraneous causes, they spontaneously suspend their efforts, and after a certain time, automatically take on a state of quiescence. Sleep, on this account, is independant of volition; and some of the phenomena of digestion will be found to result from the same circumstance.

In the explanation of natural phenomena, there are three requisites to render the solutions offered legitimate and conclusive; first, that the cause assigned be not merely assumed as an hypothesis to explain the effects, but be independantly proved to have a real existence; secondly, that it be shewn to accord in all points with the effects ascribed to it; and lastly, it is requisite that the objections to which the solution appears liable, be fairly met and answered.

The cause here assigned for explaining the periodical returns of hunger, thirst, and sleep, is the universality of the laws of motion; a point, which it is hoped, has been formerly established. The accordance of the effects with the cause alleged is next to be considered; and the objections that may be urged will be subsequently noticed.

In the stomach, the first stage of action is obviously that which begins at a certain period after taking food. That digestion does not commence immediately after eating, has long been admitted by physiological writers; a conclusion founded, no doubt, upon observation and dissection; and it may be received as a fact, although no sufficient cause has ever been assigned to account for this remarkable circumstance. The time generally supposed to elapse before digestion commences is half an hour, or more.

Whenever the organ resumes its action, be the interval more or less, since it is now in the state of greatest repletion, a slight extent of contraction will be sufficient to expel a portion of its contents; and the effort being inconsiderable, accords well with the incipient stage of mobility, or that of feeble and inefficient activity.

As the process of digestion advances, the extent of contraction required must be constantly increasing; and the more active exertion now called for, to keep up the process of depletion, indicates the approach of the second stage, which is that of vigorous or energetic action.

When the depletion is nearly effected, the reduced bulk of the organ bespeaks the increasing extent of contraction, and denotes the approach of the third stage of action. As this stage is characterized by the tendency to inordinate efforts, and the liability to uneasy sensation, the feeling which is now excited, or the sense of hunger, well accords with the last stage, being that of excessive and painful contraction.

This sensation subsides upon taking food, as the organ then relaxes and suspends its efforts with satiety, or that state of repletion, which is opposite to the state of greatest contraction or hunger.

After the stomach has been filled, transmission of its contents does not recommence for half an hour or more; and this fact, for which no adequate cause has hitherto been assigned, denotes the state of quiescence or rest following the continuance of exertion.

Thus the different periods of digestion appear to accord with the successive stages of action, followed by a state of rest. But each of these requires to be more particularly examined.

It was stated that from the period at which digestion commences, the mobility of the organ gradually increases: the strongest indication of which appears in this circumstance, that its action keeps continually increasing, while the stimulus that excites it is constantly diminishing.

The contents of the stomach are, on all hands allowed to be the stimulus that excites this organ to action; and these are con-

tinually diminishing as digestion goes on, while contraction keeps as uniformly increasing. An augmentation of mobility is thus clearly indicated, and seems the only cause adequate to account for the progressive increase of contraction under such circumstances.

In what way the contents of the stomach act as a stimulus, it is immaterial to the present question to determine; but is important on other accounts. Mechanical distension was formerly shewn to be the only cause capable of producing uniform and healthy action in involuntary organs, and distension is evidently the stimulus to the stomach. It is not, however, the permanent distension arising from the mere bulk of its contents; for distension, like every other impression, gradually loses its influence when permanently applied: but it is the distension alternately applied and withdrawn at every ascent and descent of the diaphragm in respiration.

From this it may be learned why exercise, at a certain period after eating, promotes digestion; but if violent, and used too soon after taking food, has an opposite tendency.

Violent exertion before the organ has rested sufficiently to recover its healthy powers of action, and while it is in a state of perfect repletion, must excite over-distension. But it was shewn to be a general law; that, over-distension of internal organs excites contraction of their mouths; while contraction of the organs is attended with relaxation of their mouths. This over-distension would therefore cause the pylorus, or lower orifice of the stomach, to become obstinately constricted, and prevent depletion of the organ, if exercise be violent and prematurely resorted to; but if deferred till absorption, which takes place during the state of quiescence, has somewhat lessened the contents; and when, from the stomach beginning to contract, the pylorus relaxes; then digestion is no longer impeded but promoted by exercise.

In this way may be explained, the experiment of the late Sir Busick Harwood upon two dogs. Having fed them well, he suffered one to sleep for an hour, and violently exercised the other. He then killed them both, and found the stomach

of the dog that had slept nearly empty, and that of the other quite full. From this he inferred, somewhat too generally, that sleep after eating promotes digestion, and is therefore wholesome.

Hunger, which is regarded as the third stage, or that of painful contraction, subsides upon taking food; because grateful impressions, according to a general law formerly pointed out, dispose to relaxation; and the stomach accordingly relaxes for the admission of the food, and the uneasy sensation ceases.

But without food being taken, hunger is often known to subside; because, involuntary organs, after a certain period of action, spontaneously relax; and thus when the effort is suspended, the uneasy sensation attending subsides along with it. A farther reason may also be alleged for the cessation of hunger after the organ is emptied; which is, the total abstraction of the stimulus that excites it to action. For whether the contents act by mechanical distension, or by some specific impression, both will be withdrawn by perfect depletion.

This suspension of hunger in an empty stomach, however, is shortly followed by its renewal; the cause of which may be learned from the symptoms that attend. It is proverbial to say, "that long fasting creates wind upon the stomach;" and the eructations which arise shew that air is either evolved in, or gains admission into this organ, when its action has been a short time suspended. The distension, thus renewed, becomes a fresh stimulus, and calling forth fresh efforts from the organ, which has now obtained partial rest, again excites hunger. And moreover, the impression of air is not grateful, like that of food, but displeasing, and calculated to excite resistance.

The returns of hunger are quicker or slower in different individuals; and in this respect, also, the phenomena accord with the laws of muscular action. Where the mobility is greater, and the tone and vigour of fibre less, as in females and children, the stages of action will be more rapidly passed through, and the period of painful contraction will more speedily return. Hence young people require to eat oftener than adults, and delicate persons cannot bear long fasting.

Various means are known to accelerate or retard the approach of hunger. For instance, the stomach having a nervous connection with the sensorium, is partially subject to mental influence; and hunger, like fatigue, may therefore be brought on sooner by any thing that strongly directs the attention to it; or may be postponed by causes that otherwise engage the mind, and divert the attention from it.

Among the means that retard the approach of hunger, tying a belt tight round the waist is said to have that effect. The descent of the diaphragm is thus impeded, and the effort of inspiration is thrown upon the intercostal muscles. Consequently, the distension of the stomach is no longer applied and withdrawn alternately; but the organ is subjected to permanent pressure, which rather tends to allay than excite inordinate action; just as grasping the legs or feet alleviates spasms: a mode of relief instinctively resorted to in such cases.

Opium possesses the power of assuaging hunger; and the well known property of allaying inordinate action belonging to this drug, sufficiently explains its mode of operation. The Turks employ an ingenious resource to prevent the cravings of hunger, when obliged by their religion to fast for a whole day. They take three pills of opium at once; one covered with two folds of paper, a second with one fold, and a third naked. By this contrivance they are made to dissolve in succession, when received into the stomach, and retard the approach of hunger so much the longer.

Thus the phenomena of digestion all accord with the conclusion, that a state of painful contraction in the stomach, analogous to that of fatigue in the limbs, occasions the sense of hunger.

This explanation, it is but justice to state, was first suggested by Bichât in the 3d Vol. of his Anatomie Générale, p. 355, where he observes,

"Il paroit que les muscles organiques sont beaucoup moins susceptibles du sentiment de lassitude, &c.

"Je ne sais cependant, si dans ceux où se rendent beaucoup de nerfs cérébraux, il n'a point lieu.

"Par exemple, quand l'estomac a été long tems resserré sur lui-même il est probable que la lassitude qui s'empare de ses fibres, détermine en partie le sentiment que nous nommons la faim."

Bîchât, indeed, did not pursue the inquiry, nor try to solve the phenomena upon this supposition, which militates, in fact, against a fundamental principle of his system, namely, "that involuntary organs are not subject to fatigue;" he is therefore entitled only to the credit of a fortunate conjecture.

It yet remains to meet the objections that may be offered to this view, which will most probably be taken from the morbid state; thus, it may be said, if hunger be analogous to fatigue, debility should increase it, and the weakest persons should have the strongest appetite.

This objection rests upon the ambiguity of the word appetite; and the solution of the paradox has been partly anticipated, in observing that delicate persons have the quickest returns of hunger. But the stomach may grow weary, if the expression be allowed, before it is empty, and will consequently require less food to fill it again; thus delicate persons will not be the greatest eaters.

There is, however, some truth in the statement; for dyspepsia, which proceeeds from weakness of the stomach, is often attended with voracious appetite; the reason of which is easily explained.

Where mobility is excessive, as it becomes from weakness, the range of action is increased, and extreme contraction is succeeded by extreme relaxation This change will render the appetite voracious; and such a condition of the organ may proceed from a morbid state, or may be brought on by habitual excess in eating. Children, who are most liable to indulge in this way, usually eat more, in proportion to their size, than adults; and, if left to their own discretion, will always, perhaps, eat more than is necessary or proper for them.

The marvellous instances of voracious appetite that are related, probably for the most part owe their origin to habitual indulgence in eating to excess.

It may not at first appear, why the disease of scirrhous or obstructed pylorous, which prevents the food from passing readily out of the stomach, should be attended with a constant craving for food.

This effect may partly proceed from morbid irritability of the organ causing its contents to be rejected, and thus emptying it frequently. But independant of this, the effect is what might be looked for, from mere mechanical obstruction.

Whatever impedes the transmission of the food, prevents the stimulus of distension from being gradually diminished, as the contractility of the organ keeps gradually increasing. And this, by destroying the equilibrium, necessary to healthy action, is liable to render it inordinate; as before explained, in treating of the progressive increase of mobility that takes place in the stages of digestion. The craving that attends schirrous pylorus shews, further, that the sense of hunger, in certain cases, does occur before the organ is empty.

In febrile diseases the circulation and mobility are both augmented. Why then, it may be asked, is the appetite usually lost in these cases? To explain why the appetite is for the most part lost in fever, would involve the previous inquiry into the nature of this affection, which would here be premature. Some light, however, will be thrown on the loss of appetite in explaining the production of thirst, for the decline of the former is connected with the increase of the latter.

An explanation of all the morbid changes of digestion cannot reasonably be looked for at this stage of the inquiry; a perfect knowledge of the healthy function is previously necessary: and as far as this depends upon the action of the stomach, it appears that this organ is subject to the general laws of muscular motion. But secretion forms, also, an essential part of digestion; and this leads to the examination of thirst.

On the Cause of Thirst.

During the time of eating, thirst commonly arises; and after drinking, the desire to eat returns. Occurring thus simultaneously, or rather successively, there is an evident connection between them; nor can either be thoroughly

understood without the other being taken into consideration. To explain this connection, and elucidate the nature of a symptom which bears a conspicuous part in so many important diseases, well merit the attention of the physiologist.

The commonly received opinion of the cause of thirst, is, that it arises from the dryness of the membrane lining the stomach and fauces; which dryness is removed, and thirst therefore alleviated, by taking liquids. This opinion of the cause and seat of thirst, evidently suggested by the sensible dryness of the mouth and throat which attends it, pointing out the probability of a similar state in the stomach, where the sensation seems to originate, appears, as far as it goes, fair and reasonable.

But it amounts, after all, to little or nothing. To say that thirst arises from dryness of the stomach, and is therefore removed by taking liquids, is the same as saying of hunger, that it proceeds from emptiness of the stomach, and therefore is removed by taking food to fill it. It is the mere expression of the fact, and not its explanation; and neither throws any light on the nature of this affection, nor shews why it forms a prominent feature in febrile diseases.

The point to be ascertained, is, why secreting surfaces are liable to become periodically dry; for their vessels, which perform the office of secretion, are not like the stomach itself, filled only at stated intervals, and thus liable to become empty; but they are continually supplied with fluid from the larger arteries more deeply seated.

The cause of their emptiness is by some indeed, who carry their views a little farther, ascribed to the gradual expenditure of the fluid in secretion, leaving the vessels empty.

But if this be the case, how is it that thirst prevails when these vessels are most filled and distended, as in fever and inflammation? How is it, that drinking immoderately, instead of alleviating, aggravates thirst? Whilst, on the other hand, thirst is often removed without drinking at all; as by cool air, by sudorific powders, or even by the abstraction instead of the addition of liquids, as by bleeding and active purgatives?

In reply, it may perhaps be said, that there are two kinds

of thirst, one morbid, the other natural, and the explanation given does not apply to both.

If this be admitted, then it must also be allowed, that emptiness of vessels, from expenditure of fluids, is only applicable to natural thirst, and leaves therefore half of the problem unsolved; and to the medical inquirer, the more important half, being that form of the affection for which he is called upon to furnish a remedy.

It is proposed to examine both kinds of thirst; first, that which is natural, and afterwards, that which is morbid; it will thus be seen what relation they bear to each other, and what ground there is for supposing them to be essentially different in their nature.

The solution of this problem, like that of hunger, requires that a cause be assigned, which is not only adequate to explain the effects; but which is, moreover, independantly proved to have a real existence; otherwise the explanation is no better than a mere hypothesis.

The cause assigned is here, as in the former instance, the universality of the laws of muscular motion, which apply to vascular as well as to other modes of action; a circumstance that has been already established.

Through the progressive stages of muscular action, a corresponding change was shewn to take place in the circulation of the moving organ. And the stomach, as well as others, experiences this change. Its secreting membrane and muscular coat, which are contiguous to each other, supplied by branches from the same arteries, and both subservient, though in a different manner, to the same function, must needs participate alike in this change, and sympathize with each other in the action and condition of their vessels.

Now, when the third stage of action, or that of inordinate contraction arrives, the capillary vessels also partake of the change; and their extreme branches taking on a state of spastic constriction, prevent their fluids from arriving at the secreting surface, and thereby occasion a dryness of the membrane, and thirst arises in consequence.

Thus, hunger and thirst in the healthy state appear to

result from a similar change in different parts of the same organ, from which they respectively arise*; namely, hunger, from immoderate and painful contraction of the muscular fibres, at a certain stage of digestion; and thirst, from inordinate constriction of the extreme vessels of the secreting membrane, at the same period, and consequent dryness of its surface.

Both sensations are alleviated by impressions grateful to the stomach, and in the following manner, according to laws formerly established.

Grateful impressions dispose the organs to relaxation, whether internally or externally applied; the impression of food is therefore calculated to promote relaxation of the muscular fibres, and alleviate the sense of hunger. While the impression of liquids, being external to the secreting vessels as well as grateful, doubly disposes them to relaxation, according to another general law, also formerly established, and thus restores secretion and relieves thirst.

The grateful impressions made upon the inner surface of the stomach are not only applied externally to the secreting vessels upon that surface; but likewise to the open mouths of the vessels that terminate on the secreting membrane. And these patulous mouths obeying the same law, equally relax from external impressions, and thus restore secretion.

From this view it appears why hunger is transiently relieved by liquids, and likewise why thirst is sometimes removed, or at least partially alleviated by solid food; which equally tends to remove a constricted state of vessels, and restore secretion. But copious draughts of liquid perform this purpose more readily than solid food, from their more immediate contact, as well as from their more rapid and extensive diffusion over the secreting surface.

The production and removal of thirst, thus appear to be both accounted for; but the more important part of the problem yet remains to be solved, which is the nature of morbid thirst, and the difference between the two states of this affection.

Morbid thirst, which is the attendant upon febrile and inflammatory diseases, is usually accompanied with a sense of increased heat, and is best alleviated by acids, cool air, sudorifics, purgatives, or blood letting; means which afford no such relief in natural thirst, and therein bespeak the presence of some material difference between the two.

The explanation of this difference calls for more particular attention to the nature of secreting surfaces; which owe their actual condition partly to the state of the secretory vessels, and partly to that of the ducts or orifices of those vessels, which open upon these surfaces and pour out their contents.

The analogy between these mouths or orifices of ducts opening upon exhalent and secreting surfaces, and the sphincters terminating larger canals and more capacious organs, as the stomach, rectum, and bladder, was formerly pointed out; when it was shewn that they are excited to contraction, or disposed to relaxation, by similar means, and are otherwise subject to the same laws of action.

Thus, like other sphincters, they are disposed to yield to moderate distention gradually applied, but liable to become spasmodically constricted when suddenly or inordinately pressed upon by the fluids within.

When the stomach, for instance, is distended with food, its lower orifice, the pylorus, closes; and until absorption has somewhat lessened the bulk of its contents suffers nothing to pass downwards. Eating to excess often produces, in this way, painful distention and indigestion. Obstinate constipation sometimes arises from the same spastic stricture in the sphincter of the rectum, proceeding from long retention and immoderate accumulation of fæces. Strangury is liable to occur in the same way from the sphincter or neck of the bladder becoming spamodically contracted, if that organ be over distended with urine.

In like manner the pores or mouths of the exhalents on the external surface, and the orifices of secreting vessels and excretory ducts, on the internal surface, become spasmodically closed, thereby suppressing secretion and exhalation, when these vessels are gorged with blood during inflammation or fever.

Such, then, appears to be the condition of the secreting surface which produces morbid thirst; not as in the former instance, a state of capillary constriction, but one of relaxation and over-distention of these vessels, attended with a constriction of their mouths.

The transition from the one state to the other admits of easy explanation; over-contraction of vessels naturally leading to relaxation and over-distention, just as excessive fatigue is liable to produce a subsequent state of languor and debility in the limbs, amounting often to sub-inflammation.

It may in some cases be difficult to determine where healthy thirst ceases, and morbid thirst begins.

In fact, either cause of thirst, if excessive, may be considered morbid, as exemplified in the cold and hot fit of an intermittent. Both of these are accompanied by urgent thirst, but this difference prevails, (noticed by Dr. Currie, in his Medical Reports) which denotes the opposite states of circulation producing it in each stage; that hot liquids are most grateful in removing the thirst of the cold fit; and cold liquids are most grateful in the hot fit.

In the thirst attendant upon inflammation and continued fever, the state of the vessels is obvious enough, and the reason evident why it forms a prominent feature in these diseases.

The thirst excited by extreme heat may be safely presumed to arise from a similar state of increased circulation and over-distention of vessels.

Nor does there appear any reason to doubt that the thirst of inebriation, which is also acccompanied by a febrile circulation, proceeds from the same cause.

That which is occasioned by bodily exertion may, under certain circumstances, proceed from either state; but as exercise increases circulation, and as thirst most commonly arises during the stage of active circulation, it is probable that this is also the effect of vascular fulness and distention, and therefore best relieved by cold liquids.

When however exertion has been carried to such an extent as to produce faintness, the opposite state appears then to

prevail; and a cordial will of course prove more refreshing and invigorating than a draught of cold water.

The different means that afford relief in morbid thirst, bear farther testimony to the state of circulation that occasions it; and for explaining their mode of operation, little need be added to what has already been said.

In cases purely inflammatory, the means best calculated to remove this symptom are copious bleeding, purgatives, and other modes of evacuation; which unload and relieve the distended vessels, while they moderate the force of circulation, and thus restore secretion and exhalation.

Where general vascular debility appears to be the cause, as in typhoid fever, and where no local inflammation forbids the employment of such a remedy, the affusion of cold water over the body proves a most effectual source of relief, and its operation appears simple and evident.

The constrictive influence of cold upon the vessels of the surface moderates their over distention, and thereby removes the spastic constriction of their mouths, and restores transpiration. While the same change, through the consent of action between the vessels of the external and those of the internal surface, as formerly explained, is quickly propagated to the latter also, and by renewing secretion in a similar manner, removes morbid thirst.

In febrile cases where this remedy can be safely employed, it has the further advantage of instantaneously carrying off the superabundant heat; and thus proves refreshing to the patient in a degree scarcely to be imagined by those who have not experienced its effects.

With regard to the loss of appetite in febrile diseases, it is to be observed, that this is not an invariable symptom. Intermittent fever, for instance, is an exception; and it happens not unfrequently that the appetite continues in hectic, and at the commencement of inflammatory fever, at least till the fever is fully formed; that is, so long as the capillary circulation retains the power of taking on a fresh state of contraction, evinced by partial chills, or a recurrence of the cold fit.

It is particularly in those cases, in which the capillary vessels have lost the power of renewing the state of contraction, and remain permanently relaxed and distended, as in typhus, that the appetite is wholly lost. The hot dry skin and the parched tongue in these cases indicate a loss of tone and a permanent distention of vessels, well calculated to excite morbid heat and thirst, but wholly incompatible with the renewal of natural appetite according to the explanation already given; and if any sensation arise from the irregular action of the organ, or its increased mobility in this morbid state, it is nausea, and not hunger, that results from it.

To explain the affinity between these sensations would require a longer digression than the limits of the present essay will allow. It is, however, remarkable that physiologists should long have ascribed nausea to an inverted peristaltic motion, or to an irregular action of the muscular fibres of the stomach; and yet should have overlooked the relation, thus obviously pointed out, between this and the kindred sensation of hunger arising from the regular but immoderate action of the same fibres.

The nature and cause of nausea will again come under review, in examining the action of medicines and other means that produce it.

The cause of the periodical suspension and renewal of activity in the bodily and mental powers in sleep and waking, will be reserved for the next subject of investigation.

Art. II. *On Cryptogamous and Agamous Vegetation.*

(Continued from Volume V. page 264.)

Equisetaceæ, or *Horse-tails.*

The plants called Horse-tails form this group; they are leafless, with perennial roots and hollow herbaceous stems; grow usually in marshy places, and are seldom more than three feet high. The stems are cylindrical, fluted, jointed at regular

distances, and encircled at every joint by a membranous sheath, with an indented border, which may be considered as formed by the union of an assemblage of verticillated leaves: a structure so similar to that of Casuarina, that if we were not acquainted with the fructification of this latter, we might easily mistake it for a Tree-Horse-tail. The fructification of the Horse-tails terminates their stem in a compact spike. The spike consists of small involucres that look on the outer surface like the heads of nails, or perhaps still more like the thick scales of the cypress-cones, and bear on the inner surface a row of membranous cells elongated into the form of teeth: each cell opens by a longitudinal fissure, which faces towards the centre of the involucre, and sheds a powder, the grains of which, when viewed through a microscope, are seen to be so many hermaphrodite flowers. The greenish globular germen is surmounted by a nipple-shaped stigma. The stamens, four in number, are attached in the form of a cross to the base of the germen. These are elongated narrow laminæ, covered with a fine dust, and a little widened at the top; when penetrated by moisture they contract themselves, and wind spirally round the germen; as soon as they become dry they extend into the form of a spider's claw. In the latter action they unfurl themselves by so brisk and firm an elastic jerk, that the pistil, to which they are fixed, is darted up by it to a height which is very considerable, when we consider the infinitely small weight of this little hygrometrical machine: such bounds are often repeated several times within a minute.

In the view we have taken of the organs of the *Equisetaceæ*, we have followed Hedwig, with whom, however, both Linnæus and Necker are at variance. The former, apparently misled by a certain degree of resemblance in point of shape between the staminiferous scales of the juniper, arbor-vitæ, cypress, yew, &c. &c., and the involucres of the Horse-tails, supposes the membranous cells which are produced on the inner surface of these, to be anthers, and the powder they shed to be pollen, leaving to those that come after him the task of finding out the pistils; the latter, always true to his resolution of

seeing nothing but agamous plants in the cryptogamous ones of the Swedish botanist, designates the hermaphrodite flowers of Hedwig by the term of *besimences steriles*, or bodies that have no sexual organs, and reproduce the plant without the process of fecundation. Such an organic apparatus has clearly, however, in point of shape, at least, an analogy with the flowers of several of the phænogamous species; though this may not be sufficient to establish completely the view of Hedwig; which requires the existence of pollen to be more decidedly demonstrated, and an acquaintance with the germination of the *seminula*, or fine seed.

The vessels called false-tracheæ, are found in the Equisetaceæ, where they form the wall of the medulla or pith, and shoot out ramifications towards the branches. We find a large central hollow space, and two series of smaller hollow spaces arranged symmetrically round the axis of the stem; all which hollow spaces are intercepted by cellular midrifs at the joints. The epidermis, or scarf-skin, is furnished with miliary glands.

In fact, the Equisetaceæ come nearer to the Dicotyledons than the Monocotyledons, in the nature and organization of their substance.

Mosses.

These form the most curious group of the whole of the Linnean class of Cryptogamia; and is one comprising a great number of different tribes, all indeed to a certain degree, moulded after a model, the principal traits of which pervade the majority of the species, without any striking alteration. In no group, not even in any one of the phænogamous division, is the apparatus of the organs of fructification more complex, or more deserving of our attention than here. Our wonder is excited, that beings so small as in many instances to be scarcely perceptible to the naked eye, should hold so high a rank in the vegetable creation, from the singularity of the appearances they present.

The mosses are distributed over the whole face of the globe;

they abound in moist situations; and generally prefer the shade of the forest. Many grow on the stems and branches of the larger vegetables, but are not to be confounded with those noxious parasites that consume the plant to which they attach themselves; for we often find them on trees, whose health is evinced by the vigour of their growth. The slender tufted fibres that compose their root introduce themselves into the crevices of the old bark, in which there is always a greater or less deposit of vegetable mould. Their little narrow tapered pointed sattiny leaves, collect and inhale the moisture of the atmosphere, decompose water and carbonic acid, retain the hydrogen and carbon, and reject the oxygen of the acid gas, just as the leaves of other vegetables do. So far from injuring the health of the tree that bears them, in some instances they contribute to its preservation; associating in a body, they close together their small delicate branches, and form those thick cushions or fenders, that, in northern regions, protect the roots and branches of the forest from the severity of the frost. Insignificant as may be the appearance of these cryptogamous beings, they are qualified to withstand every variation of season; after having defied the extremity of heat, they resume their verdure, and display their forms in the midst of ice and snow: nay, winter is the season when they expand.

Male and female flowers are borne separately on the same, or on distinct plants, among the mosses; sometimes at the end of the stems or branches, sometimes in the axils of the leaves; but always in *perichætia*, a sort of involucres formed by small bractes *(foliola-perichætialia)*, which overlap each other as they grow upon their tubercle-shaped receptacle *(clinanthes.)*

This receptacle or clinanthes serves as the pedestal of several flowers intermingled with a sort of hollow partitioned hairs, termed *paraphyses*. The flowers have no perianth or floral covering. It seldom happens that male and female ones are assembled in the same involucre.

Every female flower consists of an oblong germen, a slender style, and a stigma shaped like the broad end of a French-

horn. Every male flower consists of a filament, which is generally a very short one, and of a single grain of pollen of an oblong form, fixed by one of its ends to the extremity of the filament. This little bag containing the fecundating matter, is either greenish or whitish, except at its top, where it is colourless and transparent. When placed upon water, the top splits, and opens like the beak of a bird, or else rises up like a lid, and the liquid contents being poured out, run out in a serpentine stream, which spreads itself abroad till it disappears entirely. This fact, first observed by Hedwig, and confirmed by experiments recently made by ourselves in conjunction with M. Schubert, serves to give great weight to the opinion that the mosses are endowed with sexual organs.

Soon after impregnation has taken place, the style and stigma shrivel up, and the exterior pericarp (*pannexterne*) begins to extend itself. This pericarp, like that in Euphorbia and Hura *crepitans*, is formed by the exterior rind which separates from the interior parts, without ceasing to enclose them. It bears the remains of the style, and divides horizontally into two portions: the lower, termed *vaginula*, forms a little cylindric tube; the upper, termed *calyptra*, forms a hood in the shape of an extinguisher.

The germen, as it ripens, is raised up by a slender pedicle that issues from the interior of the *vaginula*. In proportion as the pedicle, or as it is technically called, the *seta*, lengthens, the hood carried up by the germen gets to a distance from the *vaginula*, which remains fixed to the receptacle or *clinanthes*. When the *seta* has acquired its full length, the germen becomes a ripe fruit, and the hood generally falls off soon after. The interior pericarp, which is urn-shaped, and is technically termed the *theca*, sometimes rests upon an *apophysis*, and is almost always surmounted by an *operculum*. The *apophysis* is a fleshy extuberance; the *operculum* a little conical cover, which detaches itself when the seed is ready to be shed, and thus leaves open the orifice of the *theca*. This fruit-vessel consists of two walls, in such way as that we may conceive it to consist of two vessels of unequal sizes, of

which the largest, termed *sporangium*, serves as the case of the other, termed *sporangidium*: these vessels are luted together at their brims. A little central pillar, termed the *columella*, rises from the bottom of the *theca*, to the level of its orifice. The *seminula*, or fine seeds, of a yellow green, or brown colour, are disposed within the innermost vessel round the little pillar or *columella*. The edge of the orifice is sometimes, though seldom, quite entire, like the brim of a drinking glass; for instance, in SPHAGNUM, GYMNOSTOMUM, &c.; but is most commonly cut out all round into small strips; when this border is termed the *peristoma*. If these little strips belong to the outer vessel of the *theca*, they are called *dentes*; if they belong to the inner one, *cilia*. Some *thecæ* have only a single *peristoma*, either of *dentes* or else of *cilia*; others have two, the outer one of *dentes*, the inner of *cilia*. The *dentes*, at the moment that the *operculum* falls of, bend and straighten themselves alternately, just as if they were furnished with nerves and muscles; an action which originates solely in a hygrometrical property, and may be produced at will by breathing on the *peristoma*. In some species (as in POLYTRICHUM, ATRICHUM) the orifice of the urn is closed by what is termed the *epiphragma*, a fine membrane attached to the *peristoma*, and which abides for a long time after the fall of the *operculum*. In some others (as for example in FISSIDENS *pulvinatus* Hed.; *Dicranum purpureum* Hed. &c.) the seam which connects the *operculum* with the orifice of the *theca* is overlaid by a flat elastic hoop, up to the instant when the *operculum* detaches itself.

The *seminula*, falling on the ground, germinate. Hedwig observed the mode of their germination; in swelling, they burst the integument which encloses their nucleus, they throw out a a radicle, a plumula, and some succulent jointed threads, at first simple, afterwards branched, and which this naturalist takes for cotyledons, but which do not resemble those of phænogamous plants, either in form, or mode of development.

This is the amount of what we know of the organs of reproduction in the mosses.

The principal views of Hedwig's theory, have been adopted in the above statement, as being in our opinion the soundest that have been propounded by any who have treated of cryptogamous vegetation; but still they have not been received without opposition from other quarters. It has been objected that in many mosses, the apparatus which Hedwig and his followers have called male flowers, is so closely enveloped, that it is not possible to conceive that the fecundating property, or *aura seminalis*, can escape so as to come at the stigma; and that, in others, after the closest investigations, not the least signs of these pretended male flowers have been detected. But these objections, in our mind, are more specious than solid. If numerous analogies in point of shape and structure conspire to prove that the greatest portion of Mosses are endowed with sexual organs, will it be sufficient to overturn an hypothesis so supported, to shew that the parts termed male organs are not present in several of them, or that the co-operation of these organs is not absolutely requisite for the developement of the *seminula?* This can hardly be admitted. We have a multitude of instances where organs serve no purpose in certain species, though in others the most important functions depend upon them. Is it not a well known fact that in the Zemni (Mus *typhlus*), a kind of rat belonging to the Levant, the eyes are concealed by a two-fold covering that renders him blind? The visual organ is to all appearance as perfect in its structure in that animal as in any other. The sclerotica, the choroides, the retina, the crystalline humour, and even the lachrymal gland are clearly defined in it; and yet the Zemni is blind.

We might produce many other analogous instances from among animals.

But to return to the vegetable creation; do we not see a multitude of plants which are constantly furnished, some with leaves, some with stamens, some with pistils, &c. so formed as to be utterly useless for the purposes for which they appear to have been produced? These are facts that admit of no dispute. Now when we know that there are organs, which may be said to exist in an unfinished state, and others

which, in spite of their apparent perfectness, are notwithstanding rendered useless to the beings provided with them, cannot we easily conceive that these organs may fail altogether in some certain species; or, to speak more philosophically, that those species may offer us no trace of such. Certain it is, that we are no more permitted to decide the final purpose of the Author of all things in the creation of particular individuals, than we are in that of the creation of the universe. This sense of our insufficiency brought home to us by our reason, should guard us from idly prying into final causes, and keep our attention steadily fixed on facts. It is clear that the hypothesis proposed by Hedwig is founded upon observations, the accuracy of which cannot be now contested.

Let us close this chapter by a summary of the systems, both prior and subsequent to Hedwig's.

Micheli, the first botanist who applied himself to the investigation of the organs of reproduction in Mosses, takes the male involucres for an assemblage of hermaphrodite flowers. According to his conjecture, the grains of pollen are pistils, and the jointed hairs stamens; to the *theca* he gives the name of fruit. Dillenius, on the contrary, will have it, that the *theca* is the male organ. The male involucres, according to him, are female flowers. In Hill's opinion the male involucres are mere buds; the *theca* contains the organs of both sexes; the *seminula* are pistils; and the teeth of the *peristoma*, stamens. Meese adopts the opinion of Hill in regard to the *theca*, and Micheli's in regard to the male involucre. Kolreuter sides with Hill, but with certain modifications: he denies to the *cilia* and teeth of the *peristoma* the fecundating power, to give it to the *calyptra* or hood. Linnæus follows the doctrine of Dillenius in regard to the *theca*, and gives no opinion in regard to the other parts. Gærtner, like Meese and Kolreuter, makes the *theca* an hermaphrodite flower; but pretends that the fecundating liquid is secreted by the *operculum*. The *theca* is likewise an hermaphrodite flower in Monsieur de Beauvois's theory; but then this botanist thinks, with Dillenius, that the *seminula*

are the pollen, and finds out of himself that the central pillar or *columella* is the pistil. With Hill, he deems the male flowers mere buds. Lastly, these opinions are assailed in the total by Necker; who, fixed in his resolve of transforming the cryptogamous beings of Linnæus into agamous or sexless ones, considers the *seminula* as what he calls *besimences steriles*, or bodies that reproduce the species without the intervention of fecundation.

As yet, no vascular tubes of any sort have been discovered in the texture of Mosses; but still it is surmised that plants, so near, in the form of the foliage and the stem, to the phænogamous vegetation, cannot be entirely destitute of them.

Hepaticæ.

The *Hepaticæ* come very near to the Mosses. They have, with certain modifications, the same sexual apparatus. Some have slender stems and a small delicate foliage: in the greater part of them, however, there are no leaves, but in their stead fronds *(frondes)*, thin succulent flat laminæ, sometimes entire, sometimes scolloped, which rise from the root, and bear the organs of reproduction.

In all the *Hepaticæ* the female flowers consist of pistils enveloped in a *perichætium*, or involucre of small bractes. Every pistil has its style and stigma, and its rind becomes a seed-vessel, which differs from that in the Mosses, by opening at the top instead of dividing horizontally: so that the fruit of the *Hepaticæ* have the *vaginula*, but not the *calyptra*. The seed-vessel, which represents the *theca* of the Mosses, has no *operculum* or lid. It is a little capsule that divides from the top downwards into several valves, or a membranous follicle which rends irregularly. It contains numberless *seminula* in the form of a fine powder.

Besides the above, there are little membranous pouches in the *Hepaticæ*, which may be deemed analogous to stamens. Hedwig has seen a liquid stream run from these pouches in JUNGERMANNIA *epiphylla*.

Micheli, Schmidel, Linnæus, and Hedwig, are unanimous

in ranking the *Hepaticæ* among those plants that are endowed with sexual organs; but they have not agreed in the definitions of those organs. We have adhered to the opinion of Schmidel and Hedwig, as being the most probable. In general, the parts which these botanists hold to be the male organs, the other two hold to be the female ones; and those which the two latter deem the male organs, Hedwig and Schmidel, on the contrary, deem the female organs.

Gærtner and Necker view all the *Hepaticæ* as agamous or sexless; and in this each is consistent in his way: Necker, because he has undertaken to deny the existence of any such being as a cryptogamous plant; Gærtner, because he recognizes the analogy between the Mosses and the *Hepaticæ;* and he has not met with an *operculum*, which he believes to be the male organs of the former, in the latter.

We might quit the subject with such general views; but let us choose some one example which may present you a more precise notion of the peculiar structure of the *Hepaticæ*, draw your attention to the investigation of them, and enable you to judge in what they resemble and in what they differ from the Mosses.

We will take for this sample the Marchantia *polypmorpha:* a little dioicous plant, very common in wet places, especially round springs and upon well-stones; its frond is green, lobed, and spread upon the ground, to which it attaches itself, by a bushy tuft of fibres; in the female plant, peduncles, which rise perpendicularly from the sinuses of the frond, bear at their summit what is technically termed the *umbrella*, a kind of involucre whose shape is implied in its name. This umbrella is divided into diverging rays; the rays are furnished underneath with fringed membranes which surround small pendant flowers, consisting of a membranous perianth, and a rounded germen surmounted by a slender style and scarcely perceptible stigma.

The *umbrella* of the male plant is less deeply divided; it is concave at the upper surface, where it is covered with nipple-shaped protuberances. It contains within its substance as

many pouches filled with the fecundating matter, as we see nipples on its surface. The pouches are oval, are furnished with vascular cords which correspond with the summits of the nipples, and to all appearance serve in the distribution of the fecundating liquid. When impregnation has taken place, the germen, after having broken from the exterior or general pericarp (*pannexterne*), becomes a campanulated *vaginula* with a denticulated border, drops down to a little below its point of insertion, supported by a very short bristle, opens at the top into several teeth which roll themselves up, and gives room for a bundle of hygrometrical threads termed *crinulæ*, to dilate and display themselves. These threads are membranous transparent tubes, tapered and fined off at each end, containing, if there is no optical illusion in the case, two threads twisted in spiral lines and intertwined with each other in contrary directions. These move and turn themselves about like hairs when put near the fire, and dart off, by puffs, numberless *seminula*, to which they have served as placenta or receptacle.

This however is not the sole mode by which this MARCHANTIA reproduces itself. It bears besides upon the frond, a kind of slightly salient conceptacles, that open at the summit by a great number of small teeth, and expand into the form of small baskets. These we shall call with Necker, *origoma*. They contain small green bulbous, fleshy, oblong, compressed bodies, whose developement has been observed by Micheli.

Lycopodiaceæ.

The *Lycopodiaceæ* recede from the Mosses in regard to the generative organs, but come near to them in their general appearance, though they are usually much larger. Their roots are tufted and ramified; their stems simple or branched: and in the latter case, their branches are dichotomously multiplied. The foliage is dispersed in spiral lines round the stems, or else one above the other at two opposite sides. They affect the shade, and abound in the forests of the north. Their long supple stems creep by the ground, and take root at different points.

They have all conceptacles with one, two, or three cells, which either form a spike or grow from the axils of the foliage. The conceptacles are filled with *seminula*, either red yellow, or brown, smooth, or bristling with points, opaque or transparent, and grouped three against three, or four against four, forming a multitude of small globular bodies. When the conceptacles are ripe, and open themselves, the *seminula* separate from each other, and constitute an extremely fine powder, which in some species, on being thrown on the fire, emits a very bright flame as it burns. Lindsey, Fox, and Wildenow have all witnessed the germination of these *seminula*.

About one-third of the known species of the *Lycopodiaceæ* have a different sort of conceptacles intermixed with those of which we have been speaking. They contain from one to four globular *seminula*, which have a loricated outside, and even a peculiar tunic, according to Mons. de Beauvois. The germination of these *seminula* has been authenticated by Brotero; so that here we have two different kinds of germens and seeds in the same plant.

However extraordinary this fact may be deemed, there can be no doubt concerning it, since it has been proved by actual experiment. Nothwithstanding this, several later botanists, bigotted to the belief that no plant is without sexual organs, still continue to adhere to the opinion of Linnæus, of Haller, and of Adanson, who hold the first kind of conceptacles to be the anthers, the second, the pistils. We shall not maintain against those botanists that the *Lycopodiaceæ* have in reality no sexual organs, but are agamous plants, because we could not demonstrate our opinion according to the strict test of experiment; but we shall observe, in order to keep up in your mind as much scepticism as is necessary to guard you from the errors to which a blind confidence may subject you, that to this hour, no well founded discovery, nor even plausible analogy goes to shew that the *Lycopodiaceæ* come more within the limits of the cryptogamous department of vegetation, than that of the agamous.

Art. III. *Some Facts relating to the Formation and Decomposition of Sugar, and the Artificial Production of Crystallized Carbonate of Lime.* *By* J. F. Daniell, *Esq.* F. R.S. *and* M. R. I.

There is no department of Chemistry more interesting or at the same time more replete with difficulties, than that which concerns the vegetable kingdom. The whole progress of vegetation presents us with a series of the most delicate chemical processes, which require such an admirable adaptation and adjustment of the nicest circumstances, as generally baffles the efforts of art in her endeavours to imitate the products of nature. We gain some insight into these operations by the work of destruction, but it is rarely indeed that we can reproduce or modify the proximate principles with which we are most familiar.

Any approximation to this desirable extension of the power of our art must, therefore, be considered of the utmost importance. It is upon this account that much of my attention has at different times been turned to the experiments of converting starch into sugar, and sugar into gum. In repeating and varying the processes of Mr. Kirchoff and Mr. Cruickshank, I have been led to some results, which may possibly be considered as worthy of record, in the present dearth of our knowledge in this branch of the science, especially as some of them tend to explain part of the processes of a very important branch of manufacture.

I have often repeated the experiment of the Russian chemist of boiling starch in water acidulated with sulphuric acid, for 38 or 40 hours, with the uniform result of obtaining from it a strong saccharine syrup, after having neutralized the acid by means of carbonate of lime. I was desirous of ascertaining whether a boiling heat were absolutely necessary to the production of this sugar, and whether it might not be compensated by a long continuance of a lower degree of temperature.

Experiment 1. 400 parts of cold water were mixed with two parts of sulphuric acid, and 100 parts of starch were added to the mixture; the whole was well shaken together in a flask and placed in a stove, the temperature of which varied from 100° to 120°; water was added every day to supply the loss by evaporation. On examining the mixture at the end of three weeks, no change was perceptible in it. The liquid floated clear above the starch, which remained in a mass at the bottom of the vessel.

Experiment 2. A similar mixture was made, substituting boiling water for the cold, and placed in the stove. It formed a weak jelly, when allowed to cool; but no other change was perceptible at the expiration of the like period.

Experiment 3. 200 parts of water were mixed with 2 parts of sulphuric acid, and made to boil in a Florence flask. 100 parts of starch were added to 200 of cold water, and carefully strained. The starch was kept suspended in the water by agitation, and the whole added in a small quantity at a time, to the boiling acid. At every addition the mixture swelled up violently, which made it necessary from time to time to remove the flask from the fire. When the whole quantity had been thus added, the mixture was suffered to cool. When cold, the starch appeared to be in part precipitated to the bottom of the liquid in a powder, and part was suspended in it; but it shewed no signs of that gelatinization which is the result of its being boiled with water alone.

It was now placed in the stove, and the evaporation of the water carefully supplied. At the end of a fortnight, a little of it examined with carbonate of lime tasted perceptibly sweet. At the end of three weeks it was taken out. A perfect solution had not been effected; part of the starch still remaining at the bottom of the vessel. It had assumed a slight tint of brown, but no charcoal had been deposited. It was thrown upon a filter, and the clear liquor having been neutralized with marble powder, was evaporated to the consistence of a syrup. It had a very pleasant sweet taste, free from any empyreumatic taint, was transparent, and nearly

colourless. It did not granulate, or form any crystals upon being allowed to stand. The residue upon the filter did not appear to differ from starch.

Experiment 4. If the liquid which swims upon the starch in the last described mixture, be saturated at the end of the first week with chalk, and evaporated, a substance entirely resembling gum arabic is obtained. It is tasteless, tough, mucilaginous, soluble in water, and precipitated from its solution by spirits of wine.

Experiment 5. The sugar obtained in Exp. 3, was found to be a mixture of this gum, and sugar. These two substances were easily separated by the action of alcohol; and this is the best method of obtaining the latter in grains.

I was next induced to try whether the substance described in the ingenious experiments of Mr. Cruickshank, as a gum arising from the decomposition of sugar, by phosphuret of lime, might not be again converted into sugar, by the action of sulphuric acid and heat.

Experiment 6. A solution of sugar was made in alcohol. Phosphuret of lime was thrown into it, but no phosphuretted hydrogen was produced. The mixture was allowed to evaporate spontaneously to dryness. It was then boiled in water and the solution filtered; but no phosphuretted hydrogen made its appearance. An equal bulk of spirits of wine was added to it, which produced a very copious, white, flocculent precipitate. This precipitate was collected on the filter and dried. It very much resembled gum in its external characters, but it possessed a bitter taste, mixed at the same time with a slight degree of sweetness.

Experiment 7. Upon adding sulphuric acid to a solution of this substance in water, with a view of subjecting it to the boiling process of the starch, I was surprized to find that the sweet taste was instantly restored, and the bitter entirely destroyed. Upon more minutely examining the reason of this change, I found that a precipitate of sulphate of lime had been formed; and by further experiments, which it is not necessary to relate, I discovered that the substance which has hitherto been

considered a gum, and described as such in all our systems of chemistry, is nothing more than a compound of lime and sugar. Its taste is highly alkaline, and it reddens the colour of turmeric paper.

Mr. Cruickshank, in the same series of experiments, discovered the compound of sugar and lime formed in the direct way, and noticed that alcohol threw it down from its solution in white flakes; but draws a distinction between it and the gum produced from the action of the phosphuret: From my experiments they proved to be identical.

Experiment 8. 1000 grains of lump sugar, 600 grains of quick lime, and 1500 grains of water were boiled together for half an hour, and set bye to cool. After having stood some hours, the mixture was examined. A very thick alkaline solution had been formed, and a considerable sediment remained. The solution had a very hot astringent bitter taste, accompanied by a slight degree of sweetness, and smelled strongly of fresh-slacked lime.

Experiment 9. 250 grains of this solution were diluted with water, and filtered. Oxalic acid was dropped into it till no further cloudiness was produced. The precipitate was collected on a filter, well washed, and dried at the heat of boiling water. It weighed 94 grains. According to the best analysis, oxalate of lime contains 44 per cent. of base; so that this quantity denotes 41.3 of lime contained in the 250 of the solution. The quantity of sugar in the same was 83 grains. And thus we may conclude, that sugar dissolved in water will take up about half its weight of lime.

Experiment 10. By slow and careful evaporation, the solution of lime in sugar yielded a solid semi-transparent mass of a yellow colour and glassy fracture, which very much resembled gum. It was however instantly decomposed by the affusion of the acids, although it resisted for a long time the action of the atmosphere.

Experiment 11. When a solution of lime in sugar is set by for some months, a very remarkable change takes place in it: the surface of the liquid becomes encrusted with carbonate of

lime, which shoots downwards in it in *crystals*, and the sides of the vessel in which it is contained are also lined with crystals of the same substance. These crystals, though minute, are well defined, and present, in my own opinion, as well as in that of some of my friends to whom I have shewn them, a very acute variety of the rhomboid. At the same time an entire change has taken place in the solution, which, if sufficient time has been allowed, has lost both its alkaline and its sweet taste. It no longer possesses the properties of a viscous fluid, flowing with difficulty, and capable of being drawn out in strings, but it exhibits the characters of a complete jelly, cohering slightly together, and breaking short when pressed. This jelly is colourless, if the solution of lime has originally been made with fine sugar, and is more or less brown, according to the quality of the latter. When in its purest state, it perfectly resembles a solution of starch in hot water, which has been set bye till cold. I have found from nine to twelve months necessary to complete the change, but the crystals of carbonate of lime may be observed in a much less time. Sometimes in the glass jar in which I have conducted the operation, instead of the formation of the jelly, I have observed a white matter forming on the sides above the surface of the liquid, which kept continually rising from capillary attraction. This matter, when slightly washed in cold water, was perfectly tasteless, of a pasty consistence, and very much resembled wetted starch. A little of it was boiled in water; it dissolved, and when cold, gelatinized. I have seldom, however, failed to obtain the jelly in the first instance. Whenever the process has seemed to be longer in progress than is usual, I have found that the addition of a little dry powdered pipe-clay has accelerated it, probably by the removal of some superfluous water. When the change has not been quite complete, I have found it a difficult thing to remove the superfluous lime and sugar with which the jelly is mixed. I have sometimes, however, succeeded by carefully washing with dilute muriatic acid.

Experiment 12. The solution of the jelly in water is not

affected by solution of iode. Oxalic acid produces in it a very slight precipitate, which, however, of course is more abundant if it has not been well purified. It is precipitated by alcohol. Acetate of lead produces with it a copious, white, dense precipitate. Silicated potash sometimes, though not uniformly in all specimens, produces an opacity. Nitro-muriate of tin also a precipitate. When evaporated to dryness, a semitransparent brittle solid of a light brown colour was the result. Its fracture was vitreous, and it was again soluble in water.

From these properties and the action of these re-agents, we may conclude that sugar, by the slow action of lime upon it, is really converted into mucilage. I was inclined at first to believe that starch was the product, both from the appearance of the transparent jelly, and from the white pasty matter which is sometimes formed; but the non-action of iode, which is now known to be an accurate test of the presence of that substance, I think precludes the idea.

As no disengagement of gas is observed to take place during the slow decomposition of the sugar, it is probable that the new compound of gum contains an excess of hydrogen and carbon over the former; the new affinity of the lime determining the union of one portion of carbon with two of oxygen.

I shall now proceed to make a few observations, connected with the foregoing remarks, on the preparation, and refinement of sugar, one of the most important branches of manufacture in this kingdom and its dependencies. It is well known that lime is one of the principal ingredients made use of in these processes, although its use is by no means clearly understood. It is probable that it was first employed as a means of saturating the free acids which are expressed from the sugar cane along with the saccharine juice; and practice soon pointed out that an excess of the alkaline earth, over what was necessary for this purpose, rather improved the quality of the produce. On this account it was natural to make trial of it also in the subsequent purification, and it is now constantly employed in this operation with advantage,

without any reason being assigned for its use, except custom and experience, or some vague notion of its absorbing an acid contained in the sugar itself, which is perfectly hypothetical. In the first instance, it is used in the solid form, and added to the liquor at the discretion of the boiler; in the second process, it is employed in a state of aqueous solution. In the former case, the quantity must be very much more uncertain than in the latter; and I have reason to believe is often in very injurious excess; and this is the more probable, as the great solubility of lime in a solution of sugar is by no means generally known. In the latter case, a certain number of gallons of lime water is used to every hundred weight of sugar, in which the quantity of the earth is always constant. The proportion generally is about 109 gallons, holding about 2lb. 4¾oz. of lime in solution to a ton. This quantity might be added in the solid state to the sugar dissolved in fresh water, taking care to select lime of good quality; and in many cases would be much more convenient than the common method.

The raw sugar, as it comes to this country, contains much lime. The refiners, for their process, select such samples as are of a hard, sharp, crystalline texture, the grains of which do not cohere together, are of a grey colour, and transparent. This they call strong sugar. Sugar that is of a soft floury feel, yellow hue, and clammy, they call weak, and reject as unfit for their purposes. But it is a well known fact, that *strong* sugar becomes *weak* by keeping, so that many manufacturers stop their work at the latter end of the year, just before new sugars arrive, on account of the disadvantage of this change of quality. One very remarkable instance of this spontaneous decomposition has come within my own observation. A hogshead of sugar from Jamaica, of peculiarly *strong* quality, by some mistake, was laid by for three years. At the expiration of that period it had become disintegrated, soft and mealy. This change I have no doubt arises from the action of the lime, analogous to what has been recorded above. I have satisfied myself further that this is the case by numerous

experiments, in which I have found that new sugar contains most lime, and old sugar most carbonate of lime; or to use the refiner's term, that sugar at the latter end of the season is more dirty than at the beginning. My mode of operating was, to examine the relative proportions of the precipitates by oxalate of ammonia afforded from solutions of sugar in pure water, and in water acidulated by muriatic acid, taking care to neutralize the latter by ammonia.

All solutions of sugar, when left to spontaneous evaporation and crystallization, afford colourless crystals of sugar. I have seen perfectly pure specimens afforded in this way by the darkest coloured syrup. The art of the refiner consists in separating the sugar from colouring matter, at the same time producing a hard and compact mass. The heat which is necessary to produce the latter quality, at the same time binds up the colouring matter with the sugar; but being the most soluble ingredient of the two, it is afterwards washed away by the gradual percolation of water. Now the use of the lime, beyond what is necessary to neutralize the acids of the cane juice in the first instance, appears to me to be to render the colouring matter more soluble, and thereby to facilitate the crystallization in the first instance, and its ablution in the second; and this I think is proved by the following experiments.

Experiment 13. Raw sugar, when it is suffered to remain for sometime in the package in which it is imported, purifies itself by draining. The syrup collects at the bottom, and forms what the refiners call *foot sugar*. 1000 grains of raw sugar of middling quality, from the Island of St. Vincent, were dissolved in water, and 1000 grains of *foot-sugar* from the same cask were likewise melted in an equal quantity. The solutions were both filtered, and oxalate of ammonia added to them. The precipitates were collected. The oxalate of lime from the former weighed 5 grains, denoting 2.2 of lime; from the latter 7 grains, equal to 3.08. 1000 grains of molasses from the West Indies (the coarse syrup which runs from the raw sugar), by the same treatment afforded 20 grains

oxalate of lime, equivalent to 8.8 of lime. So that in the raw sugar we perceive that the syrup which contains the greatest portion of the colouring matter, carries off the greater part of the lime with it.

Experiment 14. 1000 grains of good single refined loaf sugar gave 2 grains oxalate of lime = 0.68 lime. 1000 grains of coarse syrup from the same sugar, 15 grains oxalate of lime = 6.6 lime. 1000 grains of treacle, the refuse of the manufacture, gave 20 grains oxalate of lime = 8.8 of lime.

Experiment 15. A solution of brown raw sugar was boiled for a short time with some fresh precipitated alumine. The solution lost much of its colour, but upon the addition of half its bulk of lime-water, the colouring matter was re-dissolved, and it resumed its former tint.

In the process invented by the late Mr. Howard for refining sugar, the use of lime in its alkaline state is entirely discontinued. No lime, therefore, is discoverable in the products, but sulphate of lime in abundance. The colouring matter of the sugar is got rid of in a different way. This process, however, though exceedingly ingenious, is never likely to be generally adopted, it being liable to very serious objections. These I shall endeavour to explain in some future paper, in which I propose to treat at length of the present state of the sugar manufactory, and the numerous plans that have lately been invented with the idea of improving its processes.

ART. IV. *Recherches Physiologiques et Medicales sur les Causes, les Symptomes, et le Traitement de la Gravelle. Par* F. Magendie, D. M. *&c.* *Paris,* 1818. *pp.* 91.

THIS is a clear, methodical, scientific little tract, and as it contains some new and ingenious views of a subject which is peculiarly interesting to humanity, touching the treatment and alleviation of a disorder which is one of the most terrible

scourges of mankind, we shall devote a few pages to an analysis of its contents.

In general, the concretions which are found in the urine of those who are attacked with the gravel, consist of a peculiar acid, which chemists call the *uric acid*, united to a small quantity of animal matter. This acid is one of the constituent principles of the urine of man, even in his healthy state.

The uric acid is very sparingly soluble. Water at 60° dissolves only about $\frac{1}{1700}$th of its weight. At the temperature of boiling water the quantity taken up is about $\frac{1}{1150}$: it deposits itself partly in cooling in the form of small scales.

The salts which the uric acid forms with the salifiable bases, are only sensibly soluble as long as the bases themselves are so, and are contained in excess in the compound.

Acording to a recent analysis of M. Berard, the uric acid is composed as follows,

Azote	39.16
Carbon	33.61
Oxygen	18.89
Hydrogen	8.34
	100.00

From whence is derived the azote, which enters so largely into the composition of the uric acid? Is it furnished by the food, or by any other means?

Vauquelin and Fourcroy ascertained long ago that the white matter which is contained in the urine of birds, and voided with their excrements, is composed chiefly of uric acid. Dr. Wollaston has further remarked, that the proportion of acid evacuated by different species of birds depends upon the nature of their food. In the excrements of a goose which fed entirely upon grass, the white matter was only $\frac{1}{200}$ of the entire weight. In those of a pheasant, which was shut up and fed only upon barley, the proportion rose to $\frac{1}{14}$. It was yet more considerable in a fowl, which had the run of a farm, and was at liberty to pick up insects and other animal matters. A

hawk, which had been brought up entirely upon meat, furnished a very small quantity indeed of solid matter by comparison with the uric acid which was left after evaporating the urine to dryness; and lastly, the evacuations of a Soland goose, to which nothing but fish had been given, contained sometimes positively no other solid matter than uric acid.

It is evident how desirable a thing it would be to extend these observations to the alterations which would take place in the urine of the same animal from change of food. This is what Mr. Magendie has undertaken to perform. He has shewn that if we deprive a carnivorous animal, for instance, a dog, of food which contains azote for a certain time, and feed it only upon gum, oil, sugar, &c. its urine will present no trace of uric acid.

There is evidently, then, a necessary connection between the diet of an animal and the quantity of uric acid which its urine contains. Let us endeavour now to discover what circumstances may determine this acid to separate from the urine in which it is commonly dissolved.

In the present state of our knowledge, two principal causes present themselves, as likely to favour the formation of gravel, viz. 1st, an increase in the quantity of uric acid in proportion to the entire quantity of urine; and, 2dly, a diminution, from whatever cause, in the temperature of this latter fluid.

Amongst the first causes which augment the proportion of uric acid, and often produce the gravel, we may reckon, as we have just seen, high living, and the use of animal food; or in other words, the diet of the rich. The following case, which came within the observation of Mr. Magendie, well deserves to be recorded.

"M. * * *, a merchant of one of the Hanseatic towns, possessed, in 1814, of a considerable fortune, lived in an appropriate style, and kept a very good table, of which he himself made no very sparing use: he was at the same time troubled with the gravel. Some political measure unexpectedly took place, which caused him the loss of his whole fortune, and obliged him to take refuge in England, where he passed

nearly a year in a state bordering upon extreme distress, which obliged him to submit to numberless privations; but his gravel disappeared. By degrees he succeeded in the re-establishment of his affairs; he resumed his old habits of life, and the gravel very shortly began to return. A second reverse occasioned him the loss of all he had acquired: he returned to France almost without the means of subsistence; his diet being in proportion to his pecuniary means, again the gravel vanished. At length, his industry restored him to comfortable circumstances; he once more indulged in the pleasures of the table, and again had to pay the tax of his old complaint."

It would be difficult to find an experiment better made, or a more convincing proof of the direct influence which a too-nutritious regimen, or one composed of highly azotic substances, exercises on the formation of the gravel; but this is not the only cause. M. Magendie points out want of exercise, sedentary employment, indulgence in bed, &c.; the use of generous wines and strong liquors; the bad habit of too long retention of the urine; excessive perspiration. All other things equal, those who drink little, will be more exposed to these attacks than they who drink largely of weak liquors. One more circumstance—the temperature of the urine, is particularly favourable to the development of this disease in old age. M. Magendie announces that in youth this temperature is higher by some degrees than at a certain age; so that the urine of the aged, having a less dissolving power, will more easily allow of the precipitation of the uric acid.

To the general means for the treatment of the gravel, which naturally follow from its causes above pointed out, we should add those which are intended to favour its evacuation and dissolution. These means are treated of with great skill by the author of this essay. We can also recommend the chapter in which he examines the mode of action of the alkaline carbonates with excess of base. Chemistry has taught us that we thus saturate the uric acid, and that the urates which are formed are dissolved in that portion of the carbonate which is undecomposed, and carried along with the urine: but it at

the same time teaches us that remedies of this nature, far from being useful, would be hurtful, if we were not careful to drink sufficiently, and so to manage as that the urine may always contain an excess of alkali.

The last chapter of the work before us treats of gravel which is not formed principally of uric acid. But much remains to be done in this branch of the subject, both to discover the causes under the influence of which such large quantities of oxalate and phosphate of lime, cystic oxide, &c. are deposited in the bladder, and to arrive at any satisfactory results in the treatment of calculi of this description. Happily for the human race, gravel of this species is of much more rare occurrence than that which is formed of uric acid.

Art. V. *Select* Orchideæ *of the Cape of Good Hope, continued from page* 104 *of Volume* V.

Of Disperis *graminifolia,* Disperis *villosa,* Disperis *cucullata,* Corycium *bicolor, and* Pterygodium *catholicum.*

Five curious orchideous species are now added to the six, which have already been given in two preceding articles of this publication. We shall refer to the two former articles for the character of the natural order, as well as for the generic characters of Disa and Disperis. The drawings are from the same source as the foregoing six.

Note. *Vol.* 5, *p.* 105. *l.* 14. *For* Disa, *read* Disperis.

Plate I. fig. 2. Disa graminifolia.

We have not traced this plant in any recorded species. A spontaneous specimen of it, brought from the Cape of Good Hope by Masson, is deposited in the Banksian Herbarium, by the title we have adopted.

Plate I. fig. 5. · Disperis villosa.

Disperis *villosa,* flowerstalk two-leaved, one-flowered, bracte and germen villous, leaves cordately ovate, smooth underneath, ciliated.

Disperis villosa. *Swartz in act. holm* 1800. 220. *Idem in Schrader's Neues Journal.* 1. 40. *Willd. sp. pl.* 4. 59.

Arethusa villosa. *Thunb. prod.* 3. *Linn. suppl.* 405.

Plate I. fig. 4. DISPERIS CUCULLATA.

DISPERIS *cucullata,* flowerstalk, two-leaved, one-flowered germen smooth, leaves oblong and as well as bracte pubescent underneath.

Disperis culculata. *Swartz in act. holm.* 1800. 220. *Idem in Schrader's Neues Journal,* 1. 40. *Willd. sp pl.* 4. 59.

Plate I. fig. 1, CORYCIUM BICOLOR.

CORYCIUM. *Corolla* ringent, 4-parted. *Segments* upright, two of them exterior, of these *the uppermost* narrowest, in conjunction with two lateral larger retuse *interior* ones, concavely protuberant, at the base resemble the helmet or casque. The *other exterior one* is undermost and obovate. *Label* inserted by a tapered base at the top of the column above the anther, its *laminæ* or broad part spreading and folding back. *Germen,* oblong, twisted. *Column of fructification* upright, very short, narrower at the base, obtuse at the apex, winged : wings deflectent along its sides. *Anther* growing to the middle of the column under the label, twin, two-celled, cells placed rather widely apart, covered at the back by the wings of the column: *pollen masses* like those in ORCHIS, their pedicles being inserted on two appropriate *ligulæ* or strips at the upper end of the cavity of the cells. *Stigma* placed behind, convex (facing the casque) below the cells of the anther. *Seed-vessel* as usual in this tribe.

OBSERVATIONS. *This genus is very distinct from the rest of its co-ordinates, in having a four-parted corolla. The insertion of the label near the top of the column and of the two small wing-like leaflets hanging down at its sides at the back of the anther, afford the appearance of an inverted flower. The wings or leaflets the interior segments of the corolla.*

CORYCIUM *bicolor,* leaves ensiform, slightly undulated.

Corycium bicolor. *Swartz in act. holm.* 1800. 122. *Idem in Schrader's Neues Journal.* 1. 43. (bicolorum) *Willd. sp. pl.* 4. 61. Ophrys bicolor. *Thunb. prod.* 2.

Plate I. fig. 3. PTERYGODIUM CATHOLICUM.

PTERYGODIUM. *Corolla* five-parted, sub-ringent : three

segments exterior: uppermost one upright; concave, keeled, forming in conjunction with the *two* lateral obovate slightly spreading interior ones, the casque. *Two front ones* ovately lanceolate, horizontally patent, concave. *Label* of various shapes, inserted on the column between the cells of the anthers, folding back, spread out. *Column of fructification* upright, short, either obtuse or pointed at the top. *Anther* growing to the middle of the column, twin; two-celled; *cells* of different forms in different species, diverging at the sides: *pollen masses* clavately pedicled, consisting of small oblong vesicular particles resting in imbricated order, on pedicles, with a glandular base inserted at the lower part of the cavity of the cells of the anther. *Stigma* placed backwards (fronting towards the casque) at the base of the back of the anther, convex. *Seed vessel* as usual in the tribe.

OBSERVATIONS. *The cells of the anther being placed at some distance apart from each other, they might be easily mistaken for two anthers in this genus; but in fact, these cells are partly distinct and partly connected at the sides of the columns.*

PTERYGODIUM *catholicum*, stem generally three-leaved, leaves oblong, acuminated; flowers with a spathulate acuminated (cross-shaped Lin.) label.

Pterygodium catholicum. *Swartz in act. holm.* 1800. 219 *Idem in Schrader's Neues Journal.* 1. 37. *Willd. sp. pl.* 4. 57. Ophrys catholica. *Lin. sp. pl.* 2. 1344. *Amæn. Acad.* 6. 110. Ophrys alaris. *Lin. suppl.* 404.

Orchidi affinis, flore luteo. *Buxbaum cent.* 3. 12. *tab.* 21.

None of the preceding five species have been represented by any figure from the living plant; and only the last by any ever from a dried sample. None of them are known to have been cultivated in any European garden. The fanciful specific name of *catholicum*, has been evidently suggested by the label of the flower, which may, by a slight assistance of the imagination, be assimilated to the pectoral cross of a catholic prelate. All the figures are excellent, and most accurate representations of the exterior of the plants they are designed for; but we have to regret the want of dissections, or representations of the interior structure and the organs of fructification.

ART. VI. *Description of a Surgical Operation, in which parts of two Ribs and of the Pleura were removed. By* M. Richerand, *Professeur de la Faculté de Médecine et Chirurgien en Chef de l'Hopital St. Louis.*

OF the operation, of which the following is a description, the boldness, novelty, and success, render it worthy of general attention. M. Michelleau, an officer of health at Nemours, who for three years had had a cancerous tumour immediately over the heart, submitted to an operation in January last, performed by a surgeon of the neighbourhood, with the intention of removing it. On changing the first dressings, a bleeding fungus appeared in the middle of the wound, which was cauterized at each subsequent dressing, but which was rapidly reproduced. A second operation was performed, and to a greater extent; the ribs were laid bare, and even the pleura touched; nevertheless fungous flesh was still formed, and though cauterized, repeatedly re-appeared. At last the patient, despairing of any good result from these operations, came to Paris about the end of March, with the resolution of suffering any thing which held out a hope of relief from the disease and from death.

At this time a very large fungus rose from the wound, from which a reddish fluid ran in abundance; and, it was so fetid that it was impossible to remain above a quarter of an hour with the patient, without changing the air of the place. The pain was however more moderate; the patient suffered neither from perspiration nor colliquative diarrhœa. Though troubled with an old and habitual cough, 40 years of age, and of a robust constitution; yet his appearance was very favourable and encouraging.

It was now resolved that the ribs, from which it was supposed the cancer originated, should be removed, and M. Richerand had to perform this operation. He informed his patient

that he should probably have to remove part of the pleura, and found him ready to submit to every thing required.

The operation was performed on the 31st of March. The wound was first enlarged, and the sixth rib laid bare. It appeared swelled and rough for about 4 inches of its length. The intercostal muscles were cut by a bistoury, the point of which was carried along the upper and under edge of the rib; and then with a small saw, not exceeding 15 lines in length, the bone was cut at the two extremities of the diseased part. It was then separated from the pleura by a spatula, and removed; and this was done with unhoped for facility, in consequence of the thickness of the membrane beneath.

The seventh rib was found diseased to the same extent, and was removed in the same manner, but not with so much facility. The pleura was now exposed. It was evidently affected, being fungous, and occasioning the formation of fungous flesh in the space between the two ribs that had been removed. The cancerous part extended above the sixth rib; so that above eight square inches of the membrane appeared affected. As without the removal of this part, an operation which had lasted 20 minutes, and with perfect success thus far, would have remained incomplete; the determination was taken, and preparations made, to stop the bleeding, which was expected on the division of the intercostal arteries. The membrane was divided by scissars with curved blades; and, whether from the effect of this instrument, which cutting less by sawing than by pressing, rubs the parts it divides, and causes the retraction of the vessels, or whether the capacity of the vessels had been diminished by the repeated previous cauterization, not a drop of blood flowed. At this moment, however, the external air entered into the chest with rapidity, compressing the left lung, which, with the heart, envelloped in the pericardium, came towards the opening. The operator endeavoured, by placing the left hand over the aperture, to moderate the entrance of the air and prevent the suffocation, which appeared almost inevitable, and with the right hand applied on the

wound a large plaister covered with cerate. This extended over the whole of that side, and effectually prevented the ingress of air. Over this was placed a large thick cushion of lint, which was covered by some compresses, and retained in the proper position by a bandage moderately tightened.

The difficulty of respiration and anxiety of the patient were very great during the ensuing twelve hours, and he passed the whole night sitting. Towards morning, sinapisms applied to the soles of the feet and the inside of the knee, rendered the respiration more easy, and from this time the pulse increased, and the strength of the patient revived. Nothing was taken either for food or drink but an infusion of the flowers of the linden tree and of violets, with a few drops of distilled orange flower water sweetened with syrup of gum arabic. Three days passed thus. The fever was moderate, but the sense of oppression strong enough to prevent sleep. The dressings were removed 96 hours after the operation. The pericardium and the lung had adhered to the edge of the aperture, but fortunately the adherence was not perfect between the pericardium and the lung; and from the sixth to the twelfth day an abundant serosity flowed from the cavity of the chest, between them: at each dressing about half a pint was removed, which had flowed in the 24 hours. On the 13th day, the fluid, produced by the inflammation of the surfaces, ceased to appear; and on the 18th day the adhesion was perfect between the lung and the pericardium; the air of course ceased to enter by the wound, and the patient was able to lie on this side. The sleep and the appetite became as perfect as before.

The wound, though dressed until now only with a simple plaister immediately applied to its surface, diminished rapidly, and appeared very favourable. On the 21st day this dressing was left off, and the surface, covered with fleshy pimples that rose from the lung and pericardium, treated as a simple wound.

The patient was now able to move about a garden attached to the house in which he resided; and even a drive of five hours about the town, did not fatigue him. On the 27th day

after the operation, he left Paris for his own home, where he arrived without any injury.

M. Richerand took advantage of the particular circumstances of this case, to ascertain decisively the perfect insensibility of the heart, and pericardium. The patient was not, in the slightest degree, aware of the moment when the fingers were softly applied to these parts. He also observed, that during life the pericardium was so perfectly transparent, the heart could be seen within it as within a glass jar; and from this cause, it was imagined for a moment to be wanting. It rarely happens that this perfect transparency is found in the pericardium of a dead body; and M. Richerand compares this membrane to the lens of the eye, which becomes opaque and obscure on the approach of death.

As the formation of a large aperture in the breast, even with the removal of part of the body, is not necessarily followed by suffocation, hæmorrhage, or mortal inflammation of the organs to which the external air then finds free access, M. Richerand supposes it possible, that, in a disease to which the patient must necessarily fall a victim, as in hydrothorax, or a dropsy of the pericardium, an aperture may be made before the heart, which will permit not only of the removal of the water, but of a radical cure of the disease, by causing an adhesive inflammation of the surfaces, by means analogous to those adopted in the cure of hydrocele. The same operation may also be performed, to expose a lung partially affected by disease; and part of it may then be removed by ligatures. These suggested operations are allowed to be hazardous; but it is justly observed that many surgical operations, which fifty years ago were pronounced impossible, have since obtained the most complete success.

*** We have learned within these few days, that the cancer which this operation was intended to extirpate, was re-produced shortly after, and that M. Michelleau died, in consequence, on the 20th of July, without having obtained any benefit from the operation he endured.

Art. VII. *Height of the Himálaya Mountains.*

The elevation of the mountains which divide India from Tartary, has been of late a subject of disquisition. Measurements, geometrically made by persons engaged in geographical surveys at the foot of that mountain-range, have exhibited a result considered to authorize the inference, that the Indo-tartaric mountains surpass the Cordillera of the Andes, before esteemed the highest of the earth. A dissertation on the subject, inserted in the 12th Vol. of Asiatic Researches, examines the information then existing (in 1814), and supports that conclusion. The inquiry has since been further pursued; and chiefly by Captain Webb, employed on a survey of the province of *Kemaon,* recently ceded by the Nepalese to the British Government. A list of many lofty peaks of the *Himálaya* mountains, measured by him, has appeared in divers publications. It agrees, so far as it goes, with the ampler information contained in a Memoir of his survey officially furnished by him.

The Memoir, which bears date 30th Nov. 1817, supplies further measurements of more than two hundred elevated positions, geometrically taken for inaccessible heights; either barometrically or geometrically, for accessible stations; and in both methods, for twenty of those stations. It explains the mode in which the whole survey has been conducted, and these measurements executed.

The survey consisted in a series of triangles proceeding from a base, the length of which is to be determined by astronomical observations for the latitude and longitude of its extremities. The series includes a line of stations selected in the same meridian nearly, and of which the relative positions are settled by observations of latitude and azimuth. The intermediate distances being used as sides in trigonometrical computations, served to correct or verify the primary base. The correction, introduced in pursuance of this verification, was a

mean of the differences; and the corrected base is 64,960 feet, or $12\frac{1}{3}$ miles nearly. The series of triangles is extended so as to comprehend three stations, of which the latitudes and longitudes had been settled by astronomical observations long ago taken by Reuben Burrow: viz. *Pilibhít*, *Cásipur* and *Afzelgerh*. These serve as fixed points, which verify the general correctness of the whole work.

In this survey, the accessible positions are determined, with a competent degree of accuracy, from the resolution of triangles of which all the angles were observed. But inaccessible places can be less certainly determined, as but two angles can be taken. In the instance therefore of the loftier peaks of the *Himálaya*, the distances were deduced from more than one triangle, and the mean of the different results is taken. Captain Webb remarks, that the cases are very few, where discrepancies appeared amounting to so great a quantity as 100 fathoms in distance, and 100 feet in height.

Being satisfied that the distances might be relied on, he proceeded to calculate the heights of the several peaks in the snowy chain observed by him. The largest set of observations was taken at *Cálinat'h*, an elevated station, of which the height geometrically found is 6417 feet above the sea; and measured by a barometer 6388 above the level of Calcutta. Four of the same twenty-seven peaks, and among them the highest of the whole, are distinctly visible at *Cásipur;* and were then observed. This station is in the plain of *Rohilkhand*, and estimated at 650 feet above the sea. Some of them appear likewise to have been observed from other places; particularly from *Gangòlí* and *Biléthi;* the latter but 20 miles distant from heights thence measured.

Every observation was repeated with the telescope reversed; and a mean of the angles, as read off on both sides of zero, was taken. It was also ascertained, that the telescope described true verticals, by bringing the intersection of the wires into contact with a well defined object and its reflected image. Other requisite precautions were duly used to ensure accuracy.

* As. Res. xii. 258.

The heights were computed according to the formula given in the 12th Vol. of Researches of the Asiatic Society;* with an allowance for terrestrial refraction at $\frac{1}{18}$th of the intercepted arc; being the rate chosen by Captain Webb, upon the result of computations made by him, with different rates, from $\frac{1}{10}$th to $\frac{1}{20}$th, for the purpose of selecting and adopting that as the mean, under which the extreme difference of results should be found least.

The mountains measured by him are, *First*, a cluster of lofty peaks situated between *lat.* 30° 40′ and 30° 50′; within 10 on either side of *lon.* 79°. The highest summit is in *lat.* 30° 43′ 41″, and *lon.* 79° 8′ 17″. Six peaks in that group were found to be from 22058 feet to 23164 feet high; and three contiguous ones, from 19106 feet to 21611 feet. This whole cluster is apparently situated towards *Kedarnath*; that is near the sources of the *Mandakini* river.

Secondly, a group of still loftier elevation, situated in and near *lat.* 30° 20′: and between 79° 37 and 79° 55′ of *long.* The loftiest of them is in 30° 21′ 52″ *lat.* and 79° 48′ 40″ *long.* Four peaks of this group rise from 22313 feet to 25669 feet. Two contiguous ones on the east are 20686 feet and 15733 feet, and a multitude of positions towards the west have been measured from 10653 feet to 12156 feet. Capt. Webb here traced the *Gaurí* river to the place where it emerges from the snow; and he determined the elevation of the spot at 11543 feet. It is in *lat.* 30° 25′ 40″, and *long.* 79° 57′ 51″, situated about 10 geographical miles W.N.W. from the highest peak abovementioned.

In a *third* group, the loftiest (situated in *lat.* 30° 12′ 15″, *long.* 80° 15′ 43″), is 22635 feet high; encompassed by four other towering peaks from 17994 feet to 21439 feet.

On the north-west of this group is *Lebong ghat*, which was crossed in June, 1816. The crest of this pass, in *lat.* 30° 20′, *long.* 80° 27′, was found by geometrical measurement, to be 18871 feet.

Between this and another pass into Chinese Tartary, situated

* As. Res. xii. 258.

W.S.W. from it, a cluster of lofty eminences intervene. Three peaks were measured, from 19099 feet to 21150 feet; and two others nearest to the pass, of which the highest is 22441 feet. The pass itself (in *lat.* 30° 12′ and *long.* 80° 40′), was found by geometrical measurement to be 17598 feet high. The approach to it is upon very elevated ground.

Captain Webb being on the frontier of the British dominions, here received a visit from the Chinese governor of the adjacent province, who crossed by that pass, travelling over the snow. This was in the rainy season. Captain Webb had carried a series of levels geometrically to the ground where he received the Mandarin's visit; and found his place of encampment to be 14434 feet high.

To the south east of that encampment is a peak 19857 feet high; followed by others of less elevation, (one, for instance, 18398 feet) which lead to a *fifth* group of lofty peaks, measured in the progress of the last survey; the most elevated of which (in *lat.* 30° and *lon.* 80° 44′) is 22727 feet; and followed by others declining from 22238 feet to 20923 feet.

The loftiest of this *fifth* group is distinctly visible from *Pilibhít;* as is the highest of the *third* cluster; and the southernmost of the *second* group. Their heights, as determined from the result of several measures by Captain Webb, are 22277 feet; 22635 feet; and 22313 feet. One of these is no doubt the mountain which was observed by Col. R. H. Colebrooke, from two stations, *Pilibhít* and *Jét'hpúr;* and the mean of his observations, calculated with an allowance of $\frac{1}{11}$th of the intercepted arc for terrestrial refraction, gave 22768 feet.* The same mountain among others measured by Captain Webb, was observed from two more stations besides *Cálímat'h;* both nearer: viz. *Gangólí* and *Bilet'hí.* From this last mentioned station, which is a hill, or rather mountain 7008 feet high, two more peaks of the *second* cluster were likewise measured; one distant only eighteen and the other twenty geographic miles. They were also observed from the remote station of *Cáśipur,* distant more than 78 geographic miles.

* As. Res. xii. p. 258 and 266.

The loftiest summit, measured by Captain Webb, (25669 feet), was in like manner observed from several places: viz. from the remote station of *Cásipúr*, nearly 86 geographical miles; *Cálimat'h*, 47 geographical miles: and *Gangólí*, 43 geographical miles.

A multitude of other observations, not particularly noticed in Captain Webb's Memoir, have furnished materials of an abstract which accompanies it, specifying latitudes, longitudes, and elevations of nearly 260 places.

Captain Webb was not enabled to employ a barometer in an early period of his survey. No less than eight barometers, belonging to him, were destroyed, before they could be brought to use; and of several, which had been commissioned by Government, none arrived in serviceable condition. Similar ill fortune attended former endeavours to supply the surveying officer with this essential instrument.* A few months before the date of his report, however, Captain Webb obtained one, deemed to be in good order. With this he observed the column of mercury at a number of stations; and has computed their elevation by a comparison with the mean height of the barometer at Calcutta in the same season. No correspondent observation at a nearer place, nor more exactly contemporary could be procured. Such a barometric observation is but a rude approximation. However, the comparison of twenty stations measured by both methods, exhibits a sufficient agreement to show, that no very palpable error attends the geometric measurement.

It appears then from the whole result of Captain Webb's laborious researches, that the former measurements of the lofty *Himálaya* are abundantly confirmed. The elevated peaks exceed 20000 feet; and the loftiest even 25000, above the level of the sea. The uniform result of every measurement, which has been made, does establish the stupendous elevation of the *Himálaya* chain. Captain Webb's survey brings us nearer to a precise determination of the height of the loftiest peaks. Further barometric measures of the most elevated accessible places still however are wanting.

* As. Res. xi.

It appears from his Report of his Survey, that the crest of one of the passes into Tartary is, according to a geometrical measurement, 17598 feet high; another is stated to have been crossed at the yet greater elevation of 18871 feet; and an encampment is mentioned at the height of 14434 feet. These are accessible heights, to which a barometer may be conveyed: and it would be satisfactory, that an instrument for measuring the weight or the density of the atmosphere should be carried thither.

Those places appear to be in the region of perpetual congelation. Captain Webb describes his Chinese visitor as moving slowly with his train over a road buried in snow. The limit of congelation is specified by him, where he states the elevation of the spot at which the *Gauri* river emerges from the snow: viz. 11543 feet. This observation, it may be right to remark, is consonant enough to theory, which would assign 11400 for the boundary of congelation in *lat*. 30° 25′.

Other rivers were likewise traced nearly to their sources, or to the spots where they emerge from the snow. The elevation of a station, near the confluence of the *Cálí* (or *Gogra*) and *Cálapaní* rivers, was measured 11341 feet. The *Cálápání* fountain, or source of the latter river, is less than four miles distant from this confluence. Its position in *lat.* and *lon.* is given (30° 10′ 30″ N. and 80° 43′ 28″ E.), but not its height. However, a bridge of spars over the chasm which contains it, within two miles of that position, was found by geometrical measurement to be 12670 feet above the level of the sea. The boundary of congelation then would be conformable with theory, if the chasm be 1200 feet deep.

The place of encampment, to which Captain Webb carried a series of levels geometrically taken is about three miles from the bridge; its elevation as found by him, is 14434 feet; and he supposes the post in Chinese Tartary, about equally distant on the other side of the crest of the pass, whence the Mandarin came over the mountain, to be equally elevated; and thence assumes that this part of the table land of central Asia does not differ widely from 14500 feet. Upon that ground Taklakote, in Chinese Tartary, and the Monastery near the lake of *Mánasarovar*, are set down by him, in his abstract at that

elevation, and in positions likewise settled by approximation. It may be more safely assumed, that the descent from the pass on the side of Tartary continues to be rapid, and at equal distances, as on the Indian side, arrives at a like level of highest habitable spots among the mountains; that is, habitable during the short period of the summer season. The highest of such places, of which the elevation as measured by Captain Webb is given, are *Goh*, 11489 feet; *Mertólí*, 11327 feet; *Birjú*, 11314 feet: *Milem*, 11405 feet; *Múpán*, 11082 feet; *Tolá*, 11050. They are probably situated near the boundary of congelation.

Upon the whole, there appears to be no reason for discrediting Captain Webb's measurement of mountains, as reported by him. The uncertainty of terrestrial refraction, does indeed cast some doubt over geometrical computations of heights of mountains; but the great multitude of observations, some of them within less distance than twenty miles, seems to reduce the limit of possible error to a low degree. Extraordinary refraction could not uniformly afford the same results from observations made at a great diversity of times and places. Were ordinary refraction in mountainous countries delusive, results could not be uniform, which are deduced from observations made at stations very unequally distant from the object; as are those which have been before reported, and which now are so in the Memoir here briefly noticed.

H. T. C.

Aug. 25, 1818.

ABSTRACT.

Latitudes, Longitudes, and Elevations above the Sea, of Places and Stations in the Province of Kumaon.

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.*
		° ′ ″	° ′ ″		
1	Peleebheet (Hafiz Musjid) -	28 38 20 N	79 41 45 E	R. Burrow.	
	Station in Grove near do. -	28 39 16,9	79 42 19,8	—	—
	Kalee Muth (the Stockade) -	29 38 11,5	79 30 19,6	6417	G.
	Ditto, do. - -	—	—	6388,3	B.
	Himálaya Peak, No. 1 -	30 49 47,2	78 51 19,6	22345	G.
5	—— 2 -	30 49 4,3	78 52 11,3	22058	—
	—— 3 -	30 46 22,3	78 55 16,9	22840	—
	—— 4 -	30 45 46,9	78 58 46,1	21611	—
	—— 5 -	30 38 28,9	79 4 49,5	19106	—
	—— 6 -	30 42 22,9	79 6 10,9	22498	—
10	—— 7 -	30 41 57,7	79 7 28,9	22578	—
	—— 8 -	30 43 40,9	79 8 17	23164	—
	—— 9 -	30 42 4,3	79 15 16,2	21311	—
	—— 10 -	30 20 16,9	79 28 0,7	15733	—
	—— 11 -	30 20 6,1	79 33 40,8	20686	—
15	—— 12 -	30 17 59,5	79 37 7,6	23263	—
	—— 13 -	30 15 36,1	79 42 49,8	22313	—
	—— 14 -	30 21 51,7	79 48 39,6	25669	—
	—— 15 -	30 16 13,3	79 54 25,7	22419	—
	—— 16 -	30 12 3,7	80 5 26,6	17994	—
20	—— 17 -	30 11 14,6	80 7 9,7	19153	—
	—— 18 -	30 14 33,1	80 12 40,5	21439	—
	—— 19 -	30 12 15,1	80 15 42,6	22635	—
	—— 20 -	30 9 28,3	80 16 44,3	20407	—
	—— 21 -	30 6 41,5	80 28 51,1	19099	—
25	—— 22 -	30 6 18,7	80 30 22,8	19497	—
	—— 23 -	29 59 33,7	80 44 3,6	22727	—
	—— 24 -	29 57 13,3	80 50 23,8	22238	—
	—— 25 -	29 52 45,7	80 51 36,5	22277	—
	—— 26 -	29 50 44,5	80 51 31,1	21045	—
30	—— 27 -	29 49 42,8	80 54 19,3	20923	—
	Reonce Temple -	29 39 33,7	79 22 4,2	6526,7	—
	Nyathana Fort - -	29 47 56,5	79 9 32,8	5785,	—
	Seahee, Oak Tree -	29 34 14,5	79 24 4,7	7193,2	—
	Budhan Dhoora Peak -	29 28 33,7	79 13 1,1	8433	—
35	Choumoonh Temple -	29 35 41,5	79 11 35,9	6355,7	—

* A. means approximation, B. barometric, E. estimated, G. geometric.

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″ N	° ′ ″ E		
	Dhoona Giree Temple	29 47 21,7	79 17 50,1	7272,2	G.
	Dhutkot Peak	29 49 34,9	79 20 50,4	9060,6	—
	Uhree Déo Peak	29 44 42,7	79 25 8,2	7030,9	—
	Gunna Nath Stockade	29 45 56,5	79 30 29,6	6828,5	—
	Ditto	—	—	6831,7	B.
40	Binsur Peak	29 42 1,9	79 35 42,4	7896,6	G.
	Sym Deo Temple	29 36 34,9	79 40 33,9	6964,9	—
	Ditto (*a*)	—	—	6759,8	B.
	Fort Moira	29 35 7,9	79 29 49,4	5520,8	G.
	Ditto	—	—	5492	B.
	Matéhsur Peak	29 28 12,1	79 29 20,7	7710,9	G.
	Bandunee Peak	29 33 16,3	79 32 24	6725,9	—
45	Sym Deo (Station)	29 36 13,1	79 41 15,9	6923,3	—
	Pin Nath (Temple)	29 49 57,1	79 23 19,2	7627,6	—
	Bagha Ling (Temple)	29 47 30,1	80 2 27,5	7646,5	—
	Ditto. Ditto. Ditto.	—	—	7634,9	B.
	Raé Peak	29 42 21,1	79 51 49,7	7796,7	G.
	Raé Station	29 43 14,5	79 51 29,3	6594,3	—
50	Dhuj Peak	29 38 34 9	80 7 45,1	8168,3	—
	Thakil Peak	29 30 17,9	80 2 27,2	8148,6	—
	Askot Heights (Station)	29 45 46,3	80 8 56,8	5502,9	—
	Seerakot (Fort)	29 48 28,9	80 5 3	6862,1	—
	Baruh Besee Peak	29 42 49,9	80 4 40,1	7805,4	—
55	Hoom Hill	29 58 35,5	80 6 28,9	9847,4	—
	Kootulgurgh (Fort)	29 24 13,9	79 53 38,4	6321,7	—
	Baukoo Peak	29 20 36,1	80 3 7,3	6061,2	—
	Bynthuree P. (Purg. Dotee)	29 33 9,7	80 15 58,3	5543,2	—
	Kalee Nagh Peak	29 51 36,1	79 57 13,4	7398	—
60	Churalélet Peak (Dotee)	29 34 55,9	80 19 6,4	6544,4	—
	Roulakot Peak	29 33 15,7	80 24 6,3	8291,2	—
	Goal Letch P.	29 29 1,9	80 14 57	8194,8	—
	Gooput Gunga P. (?)	29 37 31,9	79 52 57,6	7192,2	—
	Usooh-Choola (Temple)	29 37 31,9	80 1 11,4	7034,9	—
65	Koomhpoor Temple	29 38 17,5	79 15 34,4	6306,9	—
	Lobagurh Fort (?)	29 58 4,3	79 10 53,3	6357,7	—
	Askot (Village)	29 45 17,5	80 10 35,9	5016,7	—
	Chipula Peak (Bootan)	29 54 22,1	80 16 52,5	13455,1	—
	Ranee Shikur Peak	29 46 41,5	80 24 1,2	10132,3	—
70	Shikur Peak	29 44 34,9	80 21 10,5	9176,3	—
	Chund Nagh Peak	29 37 37,3	80 3 56,9	7078,7	—
	Kalee River (abreast of Askot)	—	—	3273,2	—
	Déo Dhoora Temple	29 24 33	79 43 17	6669,6	—

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″ N	° ′ ″ E		
	Kilputee Stockade -	29 21 30	80 0 44	6324,8	G.
75	Chumpawat Cantonment (?)	29 19 45	79 56 17	5467,5	—
	Sooee Peak - - -	29 25 27	79 55 10	5837,8	—
	Hawal Bagh (House) -	29 38 20	79 28 23	3889	—
	Ditto. Ditto. Ditto.	—	—	3910,1	B.
	Sitolee Stockade - -	29 36 13	79 29 8	5187	G.
	Mount Browne - -	29 36 44	79 30 46	5705	—
	Ditto. Ditto.	—	—	5625,7	B.
80	St. Mark's Tower -	29 35 40	79 30 28	5405	G.
	Ditto. Ditto. Ditto.	—	—	5324,6	B.
	Fort Almora - -	29 35 30	79 30 0	5337	G.
	Ditto. Ditto.	—	—	5290,9	B.
	Hutarmul (Stockade) -	29 37 22	79 27 9	5144	G.
	Saeensoora (Village) -	29 55 32	80 28 45	6211,8	—
	Confluence Kalee and Relaghar Rivers - -	—	—	3721,8	—
85	Station below Jooma -	29 53 56	80 24 0	3924,8	—
	Jooma Village - -	29 54 18	80 23 45	6564,2	G.
	Rathee - -	29 52 57	80 23 27	5686,4	—
	Shakooree - - -	29 55 27	80 24 15	5931,2	—
	Dingathur Temple (?) *	29 48 31	80 0 16	4446,6	—
	Ditto. Ditto.	—	—	4201	B.
90	Thul Debee's Temple -	29 47 23	79 56 55	4224,8	G.
	Kandé (Village) - -	29 48 11	79 52 52	5128,1	—
	Hurrookee Than -	29 50 43	79 51 52	5717,4	—
	Odeearee Village - -	29 48 10	79 51 45	5703,5	—
	Dhumoulee - -	29 46 12	79 53 53	5375,3	—
95	Boodéra - -	29 46 43	79 54 32	4341,5	—
	Loho Thul - - -	29 50 31	79 51 52	5730,6	—
	Dusoulee - - -	29 51 30	79 53 33	5734,8	—
	Seeoulee - - -	29 50 50	79 52 0	5618,4	—
	Deodur Ghat - -	29 28 2	79 26 40	6273,7	—
100	Ghagur Ghat - -	29 24 25	79 23 3	7696,1	—
	Lohurkot Fort - -	29 27 45	79 26 7	6732,4	—
	Bheem Tal (Terrace on edge of Lake) - -	29 19 18	79 23 53	4271,5	—
	Kasheepoor (Rohisund) -	29 12 18	78 48 54,1	650	E.
	Chumrowa - -	28 46 26,9	78 58 10,8	—	—
105	Afzulgurh Fort -	29 25 52	78 32 9,5	—	—
	Kath Kee Nav Fort -	29 34 39	78 59 51	5001,4	G.
	Jeepoula Village -	29 40 13,8	79 13 31	2905,6	—

* A doubt respecting the observed angles.

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″	° ′ ″ E.		
	Byznath Station -	29 53 54	79 27 22,6	3619,4	G.
	Ditto - - - - -	—	—	3609,8	B.
	Byznath Temple - -	29 53 53,1	79 27 21,4	3541,9	G.
	Ditto - - - - -	—	—	3534,3	B.
110	Runchoola Fort - -	29 54 26,4	79 27 2,8	4034,2	G.
	Ditto - - - - -	—	—	4083,1	B.
	Kupkot Village - -	29 56 15,6	79 44 4,7	3391,8	G.
	Bilethee Peak - -	29 58 45,7	79 43 0,7	7007,8	—
	Soopee Temple -	30 3 10	79 48 56,9	—	—
	Mujgowa (Village) -	29 51 39,1	79 47 53,9	5584,6	—
	Ditto - - - - -	—	—	5544,1	B.
115	Rain Miner's Village -	29 43 43,3	79 53 10,9	5137,9	G.
	Gungolee Huth (Village) -	29 39 7,4	79 52 46,9	5801	—
	Bhinta (Village) -	29 46 40	79 19 50	4011	—
	Birgolie Ford (Ramgunga)	—	—	2099,9	B.
	Pokhuree Village -	—	—	4707,1	—
	Ditto - - -	—	—	4712	G.
120	Koosa Village - -	—	—	3596,9	B.
	Rivulet below Boongu -	—	—	4375,1	—
	Juntur Village - -	—	—	4685,8	—
	Ghotee between Shera & Shemar	—	—	5596,1	—
	Shera Village - -	—	—	3999,6	—
125	Table above confluence of Dokuhna & Ramgunga Rivers	—	—	3036,5	—
	Bulteer Village - -	29 49 5	79 59 30	3134,8	—
	Camp above Nunpapoh -	—	—	6282,2	—
	Sath Village - -	29 48 30	80 1 48	5521,3	—
130	Moonsheearee (Station) -	30 4 4,3	80 4 38	6799	—
	Renghuleea (on Ramgunga R.)	—	—	2722,6	—
	Neehuree Village -	29 54 15	80 0 15	3257,6	—
	Tejum Bridge (Ramgunga R.)	—	—	3080,6	—
	Majkat Village -	29 59 20	79 58 40	4275,9	—
135	Girgarn - - -	30 1 20	80 0 48	6559,4	—
	Munguleea (Halting Ground)	—	—	7854,5	—
	Jym Ghar (Station) -	—	—	4959	—
	Confluence Jymee and Goree Rs.	30 7 30	80 4 50	4872,5	G.
	Sooring Ghar Bridge -	30 6 25	80 5 24	4206,6	—
140	Doomum Village -	30 5 55	80 5 12	4750,6	—
	Rautee - -	30 4 42	80 4 54	5767	—
	Birneeagaor - -	—	—	5984,2	—
	Paton - -	30 9 20	80 5 48	6846,1	—
	Saeen - - -	30 7 58	80 3 52	7278,7	—

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″ N.	° ′ ″ E.		
145	Ghorpula - -	30 3 45	80 5 24	6540,2	G.
	Jynthee - - -	30 4 6	80 5 3	6446,6	—
	Minealgaor Village - -	30 4 30	80 4 42	6324,8	—
	Sungdhoora - - -	—	—	7013	—
	Sooring - -	30 5 5	80 4 48	6770	—
150	Durantee - - -	—	—	5547	—
	Busnakot - - -	—	—	5603,6	—
	Bhotgaor - - -	30 4 28	80 7 36	6109,4	—
	Botee - - - -	30 5 12	80 6 38	6461,5	—
	Bochynthie - - -	—	—	6838,7	—
155	Betolee Ghat - - -	—	—	9042,8	B.
	Kalee Moondee Ghat -	—	—	9103,7	—
	Jukoola Bridge - -	30 0 58	79 59 30	4663,1	—
	Nakuree Village - -	30 0 20	79 58 50	5595,5	—
	Ghut Ghar Water Mills -	—	—	5477,1	—
160	Ramthee Temple - -	30 0 40	79 57 28	6174,4	—
	Bisléteh Ghat - -	—	—	7483,1	—
	Hokura Village - -	30 1 5	79 54 58	5607,5	—
	Hokura Bridge (Ramgunga)	30 1 18	79 54 18	4024,1	—
	Ghoomreea Dhar - -	—	—	6186,9	—
165	Leethee R. (Ford) - -	—	—	5205,1	—
	Leethee Village - -	30 0 42	79 52 33	5830,1	—
	Goatherd's Hamlet (Lour Dhoora) - - -	30 2 41	79 51 15	7821,9	—
	Lour Village - - -	30 3 42	79 50 30	6921,7	—
	Soopee Ford (Surjoo R.) -	—	—	5659,5	—
170	Lower Soopee - -	—	—	6154,4	—
	Upper Soopee - - -	—	—	6773,3	—
	Chour Village - -	—	—	6701,9	—
	Kumérce - - -	—	—	6474,5	—
	Kurim - - - -	—	—	6512,2	—
175	Bughur Temple -	—	—	6120,8	—
	Upper Folee Village -	—	—	6330,7	—
	Rutmatha Hill -	—	—	8046,4	—
	Jugthana Village - -	—	—	5434,2	—
	Bysanee Village - -	—	—	4282,8	—
180	Lumchoola Ghat -	—	—	7170.9	—
	Lumchoola Village -	—	—	5003,1	—
	Ohjoola - - -	—	—	4324,1	—
	Jintolee Churhaee - -	—	—	5464,5	—
	Bheta Village (on Minol R.)	—	—	4987,7	—
185	Boodhulee Cheeurhaee -	—	—	5903,4	—

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″	° ′ ″		
	Bhynsurgaon (Talookh Munsaree) - - -	—	—	4862	B.
	Reservoir near Gunna Nath Temple - - -	—	—	6241,7	—
	Busolee Village - -	—	—	4609,5	—
	Colonel Lyons' House (Almora)	—	—	5485,2	—
190	Soopéh Village - -	—	—	4688,3	—
	Dhoul Cheena Ghat -	—	—	6185	—
	Koomkhet Village -	—	—	3341,7	—
	Kurulagaon - - - -	—	—	3853,1	—
	Khuréh (Station) - -	29 46 37,7	79 37 52,5	4760,8	G.
	Ditto. - - - - -	—	—	4761,2	B.
195	Raékholee Camp - -	—	—	5637	—
	Thurmolee - - -	—	—	4950,1	—
	Jagesur Temple - -	—	—	5918,6	—
	Boodha Jagesur Temple -	—	—	7089,6	—
	Sym Déo Ridge - -	—	—	6463,1	—
200	Koontola Village - -	—	—	5960,3	—
	Biluk (Station) (*a*) -	29 33 10,1	79 47 16,9	5647,7	G.
	Ditto - - - -	—	—	5854,7	B.
	Bhynsaree Temple - -	—	—	4333,7	—
	Dusoula Khét (on Shineea R.)	—	—	2093,2	—
	Dhunlekh Ridge - -	—	—	4026,4	—
205	Baruhkot (Station) - -	—	—	5161,8	—
	Ditto (*a*) - - -	29 28 1,1	79 55 9,1	5096,7	G.
	Ramesur Temple at confluence of Surjoo and Ramgunga Rs.	—	—	1500	B.
	Byza (upper fields of the Village)	—	—	4297	
	Peepul Tree, in rice fields on the Kulsilla R. - - -	—	—	2737,1	—
	Kaneekot Camp - -	—	—	5199,3	—
210	Keemar Village - -	—	—	4901	—
	Kande Temple (Salina Station)	—	—	5488,2	—
	Ditto (*a*) - -	29 28 40,7	79 41 33,4	5367,3	G.
	Beykundeh (Shilung Tree) -	—	—	4367,8	B.
	Thath (Station) - -	—	—	6144,3	—
	Ditto - - - -	29 32 28,7	79 35 24,1	6017,1	G

(*a*) These differences are entirely occasioned by the circumstance before alluded to, that in the hills, the barometer continues to fall later than the period fixed for its minimum, by the Calcutta Journal, a fact which has been ascertained by actual observation, at the last-named station, Thath.

BOOTAN PURGUNAHS.

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″	° ′ ″		
	Crest of Lebong Ghat crossed in June, 1816 - - -	30 19 43,3	80 27 24,9	18870,6	G.
215	Goh Village (Dharma) -	30 14 40,5	80 22 45,5	11488,8	—
	Simtonkur Peak (Choudars)	29 58 46,1	80 28 49,9	10662,2	—
	Jeootee Village (*a*) -	29 57 40	80 26 24,7	6310	—
	Tangling Ghat - -	30 1 12	80 27 15	11651,6	—
	Rimjoo Village - -	29 57 48	80 25 25	6779	—
220	Gula Ghar Peak (Himaleea)	30 8 19	80 32 38	21150	—
	Kela, or Seealpunt (Dharma)	29 56 30	80 25 36,3	5218,8	—
	Kela Bridge on Dhoulee R. -	—	—	3811,2	—
	Gurbeea Village (Beeans) -	30 6 55	80 41 32,6	10200,2	—
	M. Numjoong (Himaleea) -	30 2 18,4	80 39 44,6	18398	—
225	Trig. Station near Gurbeea -	30 6 1	80 39 46	10983,2	—
	Spa Bridge (Kalapanee R.) -	30 9 7	80 42 23	12670,4	—
	Beeans Rikhee P. (Himalee)	30 9 28	80 46 2	19857,2	—
	Mandarin's Camp - -	30 11 19	80 44 18	14433,8	—
	Pass to Chinese Tartary - -	30 11 45	80 48 10	17597,8	—
230	Koontas Peak, No. 1 (Himalee)	30 13 17	80 45 0	22441,4	—
	——— 2 (*a*)	30 12 47	80 46 8	20991,8	—
	Kuwalétch P. (Himaleea) -	30 8 0	80 42 52	15245,4	—
	Station near Junction of Kalee, and Kalopanee Rivers -	30 8 16	80 41 31	11341,4	—
	Scethea Létch P. (Himaleea)	30 7 28	80 40 16	15811,4	—
235	Bouling Village -	30 5 12	80 26 49	—	—
	Phakul - -	30 3 21	80 27 17	—	—
	Kalopanee Fountain -	30 10 30	80 43 28	—	—
	Tuklakot (Chinese Tartary)	30 12 45	81 2 10	14500	
	Lake Mansuriour (Monastery)	30 23 10	81 9 10		.
240	Leepooke Than (Juwahir)	30 10 5	80 4 42	9127,1	B.
	Dhurmsalu (Runr Ghar)	—	—	7946,8	—
	Runr Ghar Bridge -	30 10 50	80 4 15	6782,7	—
	Junction Budgwar & Goree Rs.	30 12 45	80 3 25	8028,3	—
	Camp on Goree R. (above snow)	—	—	9796	—
245	Relakot Village (Joohar) -	30 19 0	80 2 24	10653,2	—
	Murtoolee Village (Juwahir)	30 20 33,7	80 1 25,1	11327,3	—
	Confluence Goree and Nundee-jat Rivers - -	30 20 50	80 1 42	10513,9	—
	Mapan Village - -	30 22 8	79 59 38	11082,2	—
	Panchoo - -	30 23 15	79 59 18	11283,7	—
250	Milum - - -	30 24 50	79 59 20	11405,5	—
	Milum Temple - -	30 25 20	79 59 52	11681,8	—

No.	Names of Places, &c.	Latitude.	Longitude.	Height. Feet.	Meth.
		° ′ ″ N	° ′ ″ E		
	Milum Bridge (Goree R.) -	30 24 48	79 58 42	11343,2	B
	Goree R. emerges from the snow	30 25 40	79 57 51	11543,2	—
	Birjoo Village - -	30 22 40	80 0 6	11313,6	—
255	Boorphoo - - -	30 21 45	80 0 54	10836,1	—
	Boorphoo Bridge (Goree R.)	—	—	10695	—
	Tola Village - -	30 19 55	80 2 26	11049,9	—
	Jeanpah - -	30 21 52	80 1 9	11037,1	—
	Loan - -	30 20 0	79 59 30	12156,4	—

(Signed) W. S. WEBB, Captain.

Art. VIII. *Description of the improved Patent Portable Theodolite, invented by Mr.* Schmalcalder, *Mathematical Instrument Maker, Strand, which was noticed in this Journal,* Vol. IV. p. 384.

This instrument consists of a complete Theodolite, with a magnetic compass, telescope sight, and level, and may be mounted on the usual tripod stand, or otherwise, as required according to the size and accuracy of the instrument. The improvements consist in the construction and arrangement of the telescope and compass with regard to each other, and the manner of fixing the instrument on its stand, which in military surveying, and all cases where expedition is required, will be found particularly useful.

The instrument is represented in Fig. 1 of Plate II. in describing which, it will only be necessary to mention the parts in which this theodolite differs from those commonly used. The graduated circle of the compass is fixed to the bottom of the compass box, and the central point, upon which the needle moves, is so adjusted in height, that when the instrument is level, the upper surfaces of the needle ends, which are covered with silver, and made to come as close as possible to the circle

without touching it, are in the same plane. The outer rim, or case of the compass box, is made to move steadily upon or round the graduated circle by internal teeth, acted upon by a pinion and the milled head *a*, by turning which it may be moved quite round, and will carry with it the vernier *b*, moving in contact with the divisions. This outer rim also carries the telescope, which is supported in the Y at *c*, which admits of a vertical adjustment by its screw, and the moveable milled head *d*; and the eye end of the telescope is fixed to the piece *e*, which admits of horizontal adjustment, and has a hinge to turn the telescope up whenever it may be necessary to get at the compass, or to inspect an elevated object. Immediately within the eye-glass of the telescope a small glass prism is placed in the small box *f*, which is open at the bottom. This prism extends so far upwards before the eye-hole of the telescope (which is either elongated or made double), that it does not impede the view through it, although it affords a reflection at the same time of what is immediately under it. This may also be obtained by an inclined speculum; consequently, on applying the eye to the telescope, its field of view appears as in Fig. 2, where *g g* is the field of the telescope with its cross hairs, and *h h* the field of the prism, or reflector, which exhibits the end of the compass-needle *i*, a part of the graduated limb *k*, and the whole of the vernier *l l*, all magnified, at the same time that the object is seen in the telescope; and hence the trouble of a separate reading is saved, and the possibility of an error almost prevented.

With respect to the adjustment of the instrument, this is effected by the pieces *c* and *e*, and the 4 screws *m m m m*, which set the compass box into the horizontal plane by means of the spirit level *n*, which is not fixed upon the telescope, but upon a spring tube *o*, which fits accurately on to two truly turned projections upon the telescope tube; and to use it for taking horizontal angles, the telescope must be moved by the milled head *a*, until the index of the vernier exactly coincides with the zero of the graduated circle. The whole instrument must then be moved until the object to be observed is in the centre of the telescope, when the instrument is to be fixed,

and finally adjusted by the clamp and adjusting screws *p q*. The telescope is then to be turned by the head *a*, until the needle coincides with the central vertical hair of the telescope; and the angle will be at once seen; or the reverse of the operation may be pursued, and the instrument adjusted as in Fig. 2, with the needle coinciding with the zero; and then the telescope must be turned until the object appears. Either of these operations may be repeated in proof of each other by turning the telescope half way round by the milled head *a*.

To take vertical angles, the whole instrument must be lifted off its stand at the usual place; but instead of the pin upon which the instrument turns, and which projects above the stand and enters the socket *r*, being conical in this instrument, it is a true cylinder; and the transverse hole *s t*, which is bored correctly at right angles to the perpendicular one, also fits it accurately, so that the instrument may be placed in a vertical position on this pin, with either of the ends *s* or *t*, of the socket upwards; the spirit level *u*, is at the same time to be turned a quarter round, so as to bring it to the top of the telescope, which will give the observer a horizontal line, which may be proved in either situation by reversing the telescope; and from the horizon so obtained the vertical angles are to be measured.

The variety of proof and adjustments which this instrument admits of, will be evident to any one who has been accustomed to the use of the common theodolite; and where it is desirable to obtain accuracy in a very portable instrument, this will prove an acquisition, since every operation can be repeated and reversed without trouble or loss of time.

Art. IX. *Observations on the Orchideæ. From the Latin of* Alexander Baron Von Humboldt.

The distinction among the vegetables of the Monocotyledonous division, in regard to beauty of form and variation of hue in the inflorescence, is immense. Thus flowers, which in the *Gramineæ*, *Cyperaceæ*, *Junceæ*, and *Palmæ*, are minute, colour-

less, and inconspicuous; in the *Orchideæ*, on the other hand, are so rich in the variety of their tints, that they even exceed in this point of view the more showy beauty of the *Amaryllideæ*, *Irideæ*, and *Scitamineæ*. It is, however, in tropical regions that the *Orchidea* form the principal decoration of the vegetable kingdom; and although in the continent of New Holland (where all things are reported to be extraordinary) we find from Mr. Brown's account, that fewer species of this order are found within the tropics than between the latitudes of 33° and 35°; this must be accounted an exception to the general rule. But when we are aware that the *Epidendrous Orchideæ* delight in moisture and a mild climate, it is not difficult to conceive why they should have extended themselves in the southern hemisphere, so much towards the antarctic circle; for there they find in the winter season an atmosphere as temperate as on the declivities of the mountains within the tropics.

It is not easy to estimate the harvest of *Orchideæ* that awaits the botanist in the sequestered and shady vallies of the Andés, where the climate is mild; as yet scarcely a twentieth part have unfolded themselves to science. The whole of Europe does not present us with more than from 70 to 80 species; while on the other hand, the tropical portion of America, though so slightly explored in its mountainous tracts, has already afforded to the naturalist 244 species, of which 61 that were unrecorded have been observed by Bonpland and myself. The *Orchideæ* of the New and the Old World together, amount to about 700 species.

Though the *Orchideæ* are dispersed through the equatorial regions of both the New and the Old Continent, from the level of the sea up to the height of from 1800 to 1900 fathoms, yet we may safely assert, that in regard to number of species, colour of blossom, fragrance, as well as fullness and brilliancy of foliage, that it is in the gorges of the Andés of Mexico, New Grenada, Quito, and Peru, between the heights of 800 and 1100 fathoms, where the mean annual temperature is 19°-17° of the centrigade thermometer, and soft breezes continually prevail, that they excel those of all the world besides.

There are hardly any *Orchideæ* with spurred labels, in the equatorial regions; the types of such are peculiar to the temperate

and the frozen zones. To the northern hemisphere belong the genera ORCHIS, HABENARIA, CYPRIPEDIUM, OPHRYS, SERAPIAS, EPIPACTIS, &c.; to the southern, those of SATYRIUM, PTERYGODIUM, DISPERIS, CORYCIUM, DISA, PTEROSTYLIS, CALADENIA, &c. The equatorial *Orchideæ* are chiefly of the Epidendrous section, of a peculiar appearance, and differing from those of the temperate and frigid regions, in being usually gregarious, and in growing upon trees, while in the latter regions they are found insulated, and upon the ground. Some few species of the northern type, for instance, some belonging to OPHRYS, HABENARIA, and ALSTENTEINIA, are found within the tropics, not only on the chines of the loftiest mountains, but sometimes likewise in the plains. We know of only four species which are common to both the New and the Old World within the temperate zone; these are SATYRIUM *viride*, ORCHIS *hyperborea*, NEOTTIA *repens*, and NEOTTIA *tortilis*. It seems very astonishing to us that DENDROBIUM *polystachion*, should prove common to the mountainous parts of Jamaica, the forests of Cayenne, and the Isle of France. Can these plants be really of the same species? In the bulbs of most of the *Orchideæ* of hot climates, a white starchy substance, generally of a nutritious nature, is found; in some, as for instance, in PLEUROTHALLIS *sagittifera*, a viscous substance, applicable to the same purposes as carpenter's glue.

In general, the Monocotyledons abound in starch, which resides either in the fruit (as for example, in the *Gramineæ*, unripe *Musæ*, PALMA *Pihiguao*) in the stem, (as in *Sagus*, and *Mauritia*.) or in the root (as in the *Aroideæ*, *Taccæ*, *Orchideæ*, MARANTA *indica*, *Liliaceæ*, *Dioscorideæ*). On the other hand, sugar is contained in the juices of the *Gramineæ*, of the ARGAVE of PALMA *Areng*, and the unripe fruit of the MUSA or plantain. And when we reflect that the chymists of the present day have ascertained that the proportions of oxygen, hydrogen, and carbon, are nearly the same in both sugar and starch, and that malted barley forms a sweet wort, we shall not be surprised to find them component parts of the same plant, nor even of the same parts of a plant. The older writers should seem to have had a kind of presentiment of the transmutation of starch into sugar, as when Prosper

Alpinus broached the idea, that the plantain derived its origin from a sugar-cane ingrafted on the root of the Colocasia; and Abd-Allatif, that it sprung from a stone of the date which had germinated in the root of the Colocasia. Gluten is associated with the starch in the seed of the corn-plants, and is the principal cause of their being in the shape of bread, the staff of human life. The glutinous liquid deposited in the bulbs of the *Orchideæ*, is as distinct from the true gluten of the corn-plants, as the bird-lime produced from the bark of the holly and the misletoe berries is from that. A very pungent aroma is found in the flowers of the *Lilia*, *Asphodeli*, and *Narcissi*; as in the stigma of the Crocus or Saffron, in the fruit of VANILLA and AMOMUM *Cardomomum*; in the root of the *Cannæ* (ginger;) and in the whole tribe of *Peperomiæ*. Acids, bitters, resin, camphor, poisons, tanning matter, and vegetable milk are seldom or ever found in the Monocotyledons. Poisonous matters in this primary division of vegetables are confined to the *Colchicaceæ* and *Amaryllideæ*: while the antidote is found only in the juice of that genus of palm which we have named KUNTHIA; the bitter principle to SCILLA and the *Smilaceæ*; gum-resin to ALOE. An astringent principle, not yet well determined, belongs to DRACÆNA *Draco* and the AGAVE called *Cocuiza* in the Caraccas, and their juices are used as a caustic in surgery. I cannot conceive how it could have occurred to Fourcroy to affirm, that the Monocotyledons never produced any oil, when we see that within the tropics the Cocoa-palm is cultivated for the same purpose as the olive tree with us. It was acutely observed by Decandolle, and confirmed by the experiments of Mr. Andrew Knight, that in the Monocotyledons, where the reducent vessels are dispersed throughout the entire trunk of the plant, and do not coalesce into a bark or rind, that nearly all those qualities are wanting, with which nature has usually endowed the bark of the Dicotyledons.

Art. X. *Mr.* Cawood *on Gas Retorts. In a Letter to the Editor.*

Sir, *Leeds, 29th July,* 1818.

I lately took a journey to London, for the express purpose of inspecting the different Gas-works; and am happy to add, that opportunities were afforded me of minutely investigating the different mechanical plans that are adopted there in the various operations.

This journey I undertook, in order that I might be enabled to avail myself, in our own concerns, of every solid improvement that I might there discover. Some few I own I did find; but not so numerous or interesting as I had anticipated.

Since my return from the metropolis, we have been fully employed in preparing and planting gas apparatus ready for next winter, having in hand at this moment no less than five sets for five different establishments.

The close engagement of mind, necessarily attendant upon such a press of work, has forced me, at times, to pass hours upon a sleepless pillow. But the chief reason of my present address, is to communicate to the public, through the medium of your valuable Journal, an improvement exclusively my own; and which will be found of incalculable utility in all gas concerns of a small or large extent.

A manner of setting the retorts, so that the fire shall be *equally* communicated to the surface, affording *safety* to the *metal*, a *regular heat*, and *economy* of *fuel*, has long been a desideratum. This I have accomplished to the fullest extent. I speak of it with confidence, because we have already proved its application in practice; and have had full trial of the principle in other departments of our works, for several years. In fact, it is an improvement of so desirable a nature, for the saving of retorts, expediting the making of gas, and diminution of fuel, that I ought not to withhold it; and its advantages will be seen at once by every engineer conversant in such works.

Should you view it in the same light, I can only request that it may be favoured with an early admission into your columns, in order to give time for its adoption before the winter approaches.

I remain your obedient Servant,

JOHN CAWOOD.

Explanatory References to Plate III.

Fig. 1. Represents a bird's eye view of the grates, and retorts, with the back part of the flue.

Fig. 2. Shows a side section. AA, the retorts. BBB, the flue or oven which surrounds the retort at a distance of 4 inches. CC, 4 cast iron props, or pillars, 4 inches long; which, placed under the retorts, serve as bearers for them, and leave a cavity of 4 inches under the bottom of them. DD, the fire brick arch, which encircles the retorts at the before mentioned distance. E, the flue leading to the chimney.

Fig. 3. The end section. AA, the retorts without the mouth pieces. BBBBB, the oven, in which the retorts are placed, and wherein the fire acts in every direction. CCCC, four cast iron props, which bear the retorts. DDDD, the fire brick arch, which makes the oven. E, a flue of 6 inches square (in which is fixed a damper) which conveys the smoke into the chimney; this is placed in the front of the oven, as represented at E, Fig. 2.

Fig. 4. Represents the retorts as setin a finished state, which it is scarcely necessary to explain: however it may be proper to observe, that the front brick arches AA, are made independent of the arches which constitute the ovens; so that when the fronts are taken down, the retorts can be drawn out and replaced, without at all injuring the interior of the ovens.

An observant eye will see at the first glance, that by this method of setting retorts, an equal degree of heat is communicated to every part of them; and without placing the fire immediately beneath. And that in the heating and cooling, they are at liberty to expand and contract, not being liable to

injury from the pressure of the bricks, which have been generally used to guard the retorts in the methods heretofore used. In our own works, and in others that we have erected, we have found that the oven, when once heated, requires the least fire imaginable to keep up the required temperature; as by means of a damper, the confined caloric will keep up a constant glow upon the surface of the retorts. The retorts also are heated red-hot to the very mouths; by which the gas is more copiously and regularly evolved from the coal.

ART. XI. *Report on Mr.* Millington's *Lectures, delivered in the Royal Institution during the Session of* 1818.

THE subjects treated of were Magnetism, Electricity, and the powers of Wind and Steam, as prime movers of machinery, which were divided into three distinct Courses, the first commencing on the 11th of February and continuing till Easter; the second from Easter, to the Whitsuntide recess; and the last from Whitsuntide till the conclusion of the season.

The subject of Magnetism was introduced by some remarks and observations, tending to show the great importance of cultivating this branch of natural research, particularly to a maritime nation, and lamenting the little that was known of it, notwithstanding the magnetic influence appears to have been ascertained in the earlier periods of antiquity. Many persons, it is true, at particular periods, have been indefatigable in their endeavours to reduce magnetism to something like a theory, which would account for its effects and its changes; but this has never been accomplished, nor is it likely to be done in the present state of our knowledge; for this subject is opposed by many difficulties. All that is at present known of Magnetism is, that it exerts an attractive influence on certain bodies, such as steel, iron and its ores, and other ferruginous matter, as well as on nickel and a few of the scarcer metals in a slight degree; that the earth is itself magnetic; that magnetism may be communicated from

one ferruginous body to another; *and that a magnetic body, when freely suspended so as to turn round horizontally with very* little friction, will dispose itself into a particular direction, being nearly North and South with respect to the earth; but what it is which produces this influence, and how and by what means it acts, has never been developed. Nor have any means, yet devised, been capable of rendering magnetism perceptible to any of the senses; so that were it not for the effects it produces on those bodies with which it does combine or enter into union, we should be perfectly unconscious of its existence at all.

The great importance of magnetism is derived from the circumstance above noticed, that a suspended magnet will place itself nearly in the direction of a meridian upon the earth, and point N. and S.; and for a long time after the discovery of this property, it was imagined that the compass needle (for so the thin suspended magnet in the Mariner's compass is called), did actually point due N. and S. in all parts of the world. Experience has shewn that this is not the case, and that if a needle should in any place point in the true direction of the meridian at some stated time, it will not continue to do so, but a few years afterwards will be found to have deviated to the East or West of the true North point. This deviation is called the variation of the compass, or declination of the magnetic needle; and since this instrument is the principal guide on which the mariner can confide to pursue his trackless course over the wide ocean, it becomes an object of the highest importance to ascertain correctly the manner and periods in which these changes are effected.

Simple as this problem may appear, it is one which has hitherto baffled every attempt at its accomplishment; for the changes in magnetic variation are not only so slow as to require more than the ordinary life of a man to observe them, but they are so delicate, as to require the finest instruments, and most minute observation; and so irregular and uncertain, as to have bid defiance to all the laws which have hitherto been prescribed for them.

The difficulties which have arisen in forming an adequate theory of magnetic variations have, no doubt, in a great measure

proceeded from the want of a sufficient number of well authenticated observations, made in different parts of the world, and so registered as to be accessible to those who have leisure and inclination to pursue the subject. Such observations have indeed been made in considerable numbers, particularly since the importance of the subject has been duly appreciated; but, notwithstanding this magnetic variation is slowly progressive and retrograde, and is not subject to sudden or fortuitous changes, yet they are not found to coincide with that nicety which might have been expected, and which is essential to the formation of a true and stable theory. The reason of this want of coincidence was attempted to be explained in the progress of the Course, and the object of the present Lectures was to bring into one focus most of the leading facts respecting magnetism already ascertained, and to point out the difficulties which have occurred in obtaining them, as well as the means of avoiding them in future.

That the whole earth is magnetic, has long been placed beyond all doubt, from the circumstance of a suspended needle or magnet being affected in every part of it, and drawn into nearly the N. and S. direction; but on examining the particular ingredients of which the earth is composed, it will be found that none of them possess magnetic virtue except the ferruginous substances, and a few of the scarcer metals; and that it resides chiefly in some of the ores of iron. None of the earths, of which the greater part of our globe is composed, shew any symptom of it; and, consequently, since the whole earth is magnetic, though composed chiefly of materials incapable of combining with magnetism, it may be fairly concluded that the general magnetism of the earth is disseminated through its whole body by the agency of ferruginous matter, which chemistry shews is more generally distributed and common in nature than any of the other metals. The presence of metallic iron is not, however, essential to the existence of magnetism; for many of the ores of iron which are magnetic to so great a degree as to be denominated natural magnets or loadstones, are so poor in metal as to be deemed unworthy of being smelted; while others which are extremely rich in metal, possess little or no magnetic

virtue. All the varieties of natural loadstone are, however, ores of iron, and their value is estimated by the force of the attractive power they possess. The most esteemed loadstones are those which are brought from Golconda and China ; they are very compact, and of a very dark colour. The magnets of Arabia are in thin flat plates resembling a dark slate, and are very strong. The island of Elba is also remarkable for its natural loadstones, the best of which are nearly black, and very compact ; though the same place produces what is called the white magnet, a substance possessing but little power, and in appearance very much resembling common fuller's earth, but much harder. Magnets are also common in Germany and Sweden, but they are less esteemed, and are frequently porous or honey-combed, and do not retain their power so well as those of a more compact formation. They are also found in some parts of Great Britain, and generally wherever iron ores abound. Their specific gravity is on an average about 7; and they all lose their power of attraction by long disuse, by becoming rusty, and by being made red hot.

On presenting a piece of natural magnet to a small piece of iron wire, its attractive power will be manifest : but it will be seen that this power does not reside equally in all parts of the stone, but only on two of its sides opposite to each other, and there it will be found concentrated into two small spaces, which are called the *poles* of that magnet ; all the remaining parts shew no sensible signs of attraction. An imaginary line which joins these opposite poles together is called the axis of the magnet; and, if a magnet be broken in several pieces, it will be seen that each piece will instantly acquire its own poles and axis, arising perhaps out of a part which was quite ineffective in the entire magnet; which proves that the poles do not proceed from any particular arrangement or construction of the stone, but from circumstances connected with the magnetism itself, and which some have endeavoured to explain on the principles of a magnetic circulation; and that from the magnetic matter or fluid, as it has been called (though without due authority), finding a difficulty in entering or passing out of magnetic bodies, it would become condensed or accumulated, and occasion the poles.

Magnetism is very easily communicated from one body to another, provided that body has an affinity or disposition for it; such bodies may be called *magnetizable*; such bodies as have no disposition to receive it, *unmagnetic*; and such as are magnetizable and have already combined with it, *magnetic*; and these distinctions will in future be used in this paper.

If the pole of a loadstone be presented to a piece of soft iron, or any magnetizable matter, that matter will instantly become magnetic, and will have its poles, and be capable of lifting another piece of iron at its extreme end; and this will sometimes lift a second in like manner, so long as the first is kept in contact with one of the poles of the original loadstone; but so soon as it is removed, its power likewise vanishes. If a piece of hardened steel be substituted for the soft iron in this experiment, it will not so instantaneously become magnetic; but when it does so, it will retain its magnetism permanently after being removed from the loadstone; and on this principle bars of hardened steel may be rendered magnetic, by rubbing one of the poles of a natural loadstone over them in one direction only from end to end; and the bars thus prepared are called artificial magnets, or bar magnets only, to distinguish them from the natural mineral production, which is generally called loadstone. It must however be understood, that this is not the most efficient process for preparing artificial magnets, as that will be noticed hereafter.

In the process of communicating magnetism from a loadstone to a steel bar, the loadstone does not lose any of its original power, but, on the contrary, sometimes has it increased; but no magnet will communicate greater power to another than what it first possessed; and as loadstones seldom equal the strength of artificial magnets, of course they do not offer the best means of producing them; but an artificial magnet, when produced, will exhibit all the magnetic characters of its original. It will attract iron at its two poles; will be neutral about its central or equatorial parts; and may be used to communicate magnetism to other steel bars without having its virtue impaired; and as such magnets are much more easily procured than loadstones, and may be strengthened by artificial means, they are generally made use of for experimental purposes, in preference

to the natural loadstone. The power of magnetic attraction was supposed by Muschenbroeck to be as the cubes of the distances of the attracted body; and although both poles have in common the power of attracting all magnetizable substances, yet, so soon as these are rendered magnetic, this effect ceases; and now an appearance like affinity occurs; for the pole of one magnet will attract one of the poles of another, while its opposite one will be repelled; a circumstance which is rendered very evident by means of a compass needle, or magnet, balanced so as to turn on its centre; for on approaching this with a magnet, one end will be violently attracted, and the other equally repelled; and on reversing the ends of the magnet presented, the effects on the needle will also be reversed. This shews a dissimilarity in the two poles, and renders it necessary to distinguish one from the other, which is done by calling them North and South poles; for since one end of a suspended magnet will always point towards the northern part of the globe, and the other towards the southern, so denominations are given to them accordingly; and that end of a magnet, which if it were freely suspended, would turn to the North, is called its North Pole.

This affinity or attraction between dissimilar poles, and repulsion between similar ones, is an established law in magnetism, and one upon which its principal phenomena depend. Whenever, therefore, two suspended needles are placed so near together that their own reciprocal powers overcome the natural power of the earth's magnetism, the N. end of one will attract and adhere to the S. end of the other, and *vice versa*; and the same cause regulates the pointing of the compass towards the poles of the earth; for as every magnet, large or small, will have its poles, so of course the earth's magnetism will have the same effect on all magnets upon its surface, as any other magnet would have; and as the earth's magnetic poles happen to lie not very far removed from the poles upon which it makes its diurnal revolution, so likewise will the poles of the compass needle be turned towards the earth's poles in obedience to this law.

All the experiments which are performed on magnetism, seem to indicate the flowing or circulation of the magnetic influence, in one direction only, through all such bodies as are capable of

conducting it; and on this account, neither the straight bar magnet, or natural loadstone, possess the best form for maintaining their strength; but bar magnets should be deposited in pairs, lying in a direction parallel to each other, but with their poles in opposite directions. These poles should then be united by bits of soft iron called conductors, and the magnets, should be separated from each other by a strip of wood. In this way if they are kept free from rust, their power may be maintained unimpaired. In like manner the power of natural magnets is preserved by what is called *arming* them. An armed magnet is nothing more than a piece of loadstone having two equal pieces of soft iron applied to its poles, and secured there in such manner as to project equally beyond the body of the stone: these pieces of iron will of course immediately become magnets, and will exert their force upon an iron conductor extending from one iron to the other. The power of the loadstone is much increased by this means, and it may thus be preserved for ever.

Those bent magnets, called *Horse-shoe magnets*, depend on the same principle. They are merely bar magnets, so bent that their contrary poles come nearly in contact with each other, and act together upon a conductor, or whatever they have to lift; and on account of the circulation being thus promoted, they not only act with much greater force, but will preserve their virtue so long as the conductor is kept applied to them. The compound horse-shoe magnet is the strongest magnet which can be produced, and consists of a number of thin horse-shoe magnets disposed by the side of each other, and riveted together, taking care to place all the similar poles on the same side. That end of every artificial magnet which would turn towards the North, if suspended, has always a notch or some mark to distinguish it, and it is called the North pole of the magnet, though in fact it is properly the South, since it points to the N. pole of the earth: and opposite poles always attract each other.

The circulation of a magnetic effluvium was long considered as proved by the experiment of strewing iron filings upon a sheet of paper stretched over a magnet, when they will be thrown into the form of a curves apparently stretching forth from one pole of the magnet towards the other. But the explanation which Professor

Robison has given of this phenomenon, is much more rational and correct. For since no attraction or repulsion can take place without an opposite state of magnetism is previously induced, so each particular filing, while in contact with the magnet, becomes itself a magnet, and possessed of polarity; and since these small magnets, while lying contiguous to each other, will have all their similar poles in the same direction, they will each naturally repel the other, and produce the curves in question, the forms of which admit of demonstration on this principle; and he gives examples of formulæ to calculate them. By his reasoning, every suspended needle affected by an artificial magnet, or the natural magnetism of the earth, will dispose itself into the direction of a tangent line to that particular curve upon which it happens to be placed.

The existence of distinct poles as they occur in every magnet is very difficult of explanation, and has only been accounted for on the same principles as are usually applied to electricity; namely, that there are either two distinct species of magnetism which have a strong attraction for each other while separate, but which neutralize and destroy each others powers by union; or that magnetism exists in a plus and minus, or positive and negative state in bodies, but with a constant tendency to equalization; so that a positive or abundant pole will always attract a negative or deficient one, and by producing an equilibrium, will, while they are in contact, annihilate the peculiar characters of both. Either of these hypotheses will explain most of the phenomena of magnetism, and both of them have been ably defended; but the great difficulty is to conceive the possibilty of two principles of an opposite nature, but which have the strongest affinity or attraction for each other, existing together in the same bar of steel, with sufficient force to unite with other bars, and yet that they shall be incapable of effecting a union between themselves, particularly as iron and steel seem capable of conducting or conveying magnetism.

A different state of electricity may be produced by induction in the two ends of a conducting body, by the disturbance produced by the approach of another body of greater electric energy than

itself; but this will be but an instantaneous effect; for the electricity will equalize itself, unless the obstruction of some non-conducting matter interferes. In magnetized iron this also appears to be the case; for a piece of soft iron brought into contact with one of the poles of a magnet, instantly acquires polarity, and becomes as it were part of the same magnet, although when removed it loses all its power, either by actual loss, or by equalization and consequent neutralization of all the magnetism it had received. But with hardened steel this is not the case; it acquires magnetism more slowly, and having acquired it, retains it permanently.

Now, since iron is evidently a conductor of magnetism, and steel is a conductor of it also, though apparently a much less perfect one, from its admitting and transmitting it so slowly, and steel differs only from iron by the carbon it contains; may not this, in some way or other, interfere to destroy the conducting power of iron, and cause steel not only to retain its magnetism permanently, but prevent that equality of distribution which would annihilate the existence of separate poles, had the magnetism the power of diffusing itself? And may not the various charges of carbon which enter into combination with iron affect its magnetic virtues, in such a way as to render it more or less fit to receive, retain, or transmit magnetism? This idea seems in some measure strengthened by the experiments of M. Brisson, of Paris, on the kinds of steel which were best suited to the purpose of making artificial magnets, when he found that English blister steel was decidedly the best; the fine German steel called *étoffe de Pons*, was the next best; French steel from Amboise was worse; and the finest cast steel, which is considered the best for cutlery goods, was the very worst for magnetic purposes. English blister steel made by cementation contains from $\frac{1}{200}$th to $\frac{1}{150}$th part of carbon, while cast steel contains from $\frac{1}{90}$th to $\frac{1}{50}$th, a quantity which in all probability might destroy its power of receiving permanent magnetism; since cast iron, which contains from $\frac{1}{15}$th to $\frac{1}{20}$th part of carbon, is incapable of receiving it, and is not so powerfully attracted as other iron; and plumbago, which contains $\frac{9}{10}$ths of carbon, does not sensibly affect the

needle. The paste invented by Dr. Gowan Knight, for forming artificial magnets, and which Mr. Wilson says* is composed of the scales of iron found round a smith's anvil (protoxide of iron), very finely powdered and worked into a paste with linseed oil, and then moulded and dried, also appears to offer some confirmation of the use of carbon; for though he does not mention it directly, he says the iron must be incorporated with something that contains the inflammable principle; on which account he prefers linseed oil,

If then carbon, or any other, at present unknown, principle which may enter into the composition of steel and the natural loadstone is capable of offering a barrier to the progress of magnetism, or of inducing any change or decomposition in its nature, some light will be thrown on the difference of the poles. For in the one case, a difficulty of entry and passage will cause an accumulation of magnetic influence at one end, while there will be a paucity at the other; or admitting that a division or decomposition of the magnetism (should it be compound) takes place in its passage through the steel, then one energy may be directed to the one end, while the other passes to the opposite one; and thus, as in the electric column of De Luc, opposite states will be induced and maintained at the opposite ends of the same instrument.

The process which is employed for the production of artificial steel magnets, seems to indicate a circulation or motion of some subtile effluvium, though no evidence of its existence can be adduced. The double touch of Mr. Canton, described in the Phil. Trans. for 1751-2, is perhaps the best of all processes, although those of Mr. Œpinas and Mr. Cavallo answer very well. The simplest means, however, of producing artificial magnets, is to pass a strong horse-shoe magnet over the bars previously hardened and prepared. If bar magnets are to be produced, the bars must be laid in a longitudinal direction, on a flat table, with the marked end of one bar against the unmarked end of the next; and if horse-shoe magnets are required, the pieces of steel previously bent into their proper form must be laid with

* Phil. Trans. Vol. 69.

their ends in contact, so as to form a figure like this ⊂⊃, observing that the marked ends come opposite to those which are not marked; and then, in either case, a strong horse-shoe magnet is to be passed with a moderate pressure over the bars, taking care to let the marked end of this magnet precede, and its unmarked end follow it, and to move it constantly over the steel bars so as to enter or commence the process at a mark, and proceed to an unmarked end, then enter the next bar at its marked end, and so proceed. After having so passed over the bars ten or a dozen times on each side, and in the same direction, as to the marks, they will be converted into tolerably strong and permanent magnets; but if after having continued the process for some time, the exciting magnet is moved but once over the bars in a contrary direction, or if its S. pole should be permitted to precede, after the N. pole has been first used, all the previously excited magnetism will disappear, and the bars will be found in their original state. This seems to show an effect of circulation rather than of any internal mechanical arrangement; and from the circumstance of a stronger power in proportion being produced in thin plates of steel than in thick ones, and the acquired magnetism being diminished by rust, filing, or grinding, it appears that the virtue communicated is more external than internal.

Professor Robison ascertained that the acquisition of magnetism was facilitated by a slight vibration, though a more violent one, after it is acquired, is always detrimental; for bending a magnet, the violent blow of a hammer, or even a fall, will in most cases disturb or diminish the power, and sometimes completely destroy it.

It was discovered as far back as 1576 by Robert Norman, that when magnetism is communicated to a bar of steel previously well poised upon its centre of gravity, it immediately lost its balance, and that end which turned towards the north became the heaviest. It was not, however, then suspected that this acquisition of apparent weight was at all influenced by the latitude of the place in which the experiment was made, which has since been discovered to be the case; for the north end of the needle seems to acquire more weight as the north pole is approached, while near the equator it maintains its balance, and in southern latitude it is the south end of the needle which pre-

ponderates. This effect, which is called the dip of the needle, does not therefore depend upon the quantity of magnetism imparted to the needle, or any weight which it possesses, but entirely upon the principle demonstrated by Professor Robison, that every needle at liberty to move, will place itself in a tangent line to the particular magnetic curve in which it happens to be placed. Of course, over the earth's magnetic equator, or the line which is equally acted upon by the N. and S. poles, that tangent will be parallel to the earth's magnetic axis, and the needle will lie horizontally, or without dip; but so soon as it is moved northward, the earth's N. magnetic pole will exert a greater power over the N. end of the needle, than the S. magnetic pole will over the S. end of it; and of course the N. end of the needle will dip or incline towards it, and will do so in an increasing degree as it approaches the N. magnetic pole, until it gets completely over it, or opposite to it, when it will stand perpendicularly with its N. end downwards, and be incapable of traversing at all. Of course, similar effects would be experienced upon approaching the earth's S. magnetic pole, but with the contrary end of the needle. The consequence is, that the needle and card of the mariner's compass will not balance equally well in all latitudes, but will require adjustment by weighting that side which becomes the lightest. Capt. Cook once experienced this effect to a very great degree.

An instrument called the dipping needle, is made for the purpose of observing and estimating this depression of the N. end of the needle below the horizontal line. In this instrument the needle is not allowed to traverse horizontally, as in the compass, but is made to move vertically like a scale beam, the two ends of the needle being almost close to a finely divided brass circle for estimating the quantity of its motion, and this circle is accurately adjusted into the magnetic meridian of the place where it is to be used. The needle is very accurately balanced before it is rendered magnetic, and it is made to move with as little friction as possible. Magnetism is then communicated to it; when in the northern hemisphere the N. end will immediately dip, and the angle of depression will be shewn on the circle. This angle at London is about 72 degrees, but will increase or decrease as the

instrument is moved considerably to the N. or S. Dr. Lorimer proposed a form of dipping needle, which, by having both a vertical and horizontal motion, was to adjust itself to the meridian, and answer the purpose of a compass; but the friction of this instrument overbalanced its promised advantages.

After the invention of the dipping needle, very sanguine hopes were entertained that it would answer the important purpose of determining the latitude at sea; for as the quantity of dip appeared to be little or nothing at the equator, and increased towards either pole of the earth, it was conceived, that each particular latitude would have its proportional quantity of dip; and had the magnetism of the earth been as equally and regularly disposed as it was originally supposed to be, the idea would have been very feasible; but in carrying it into execution, it appeared that no correspondence which could be relied upon existed between the dip and the latitude; for in different longitudes upon the same parallel of latitude, such a variety of dips occurred as to leave little hopes of reducing them to any laws which might account for their difference; neither did the magnetic equator at all coincide with the equator of the earth, and hence dips appeared where none should have occurred; and the project was given up as altogether impracticable.

The dip of the needle is subject to very little variation in any one place, insomuch that, according to the best authorities, it has not increased quite half a degree in England during the last 250 years. If the dipping needle will not answer the more important purpose of indicating the latitude of the place in which it is situated, still, with the assistance of the compass, it points out the direction of the earth's magnetism with regard to that place; and as 72° (the dip in England) approaches nearly to a perpendicular position, so, it is found that all bars even of soft iron which have stood long in a perpendicular direction, will have acquired polarity. This will be found to be the case in fixed iron railing, and even in common fire irons, by the assistance of which an artificial magnet may be produced without the interference of one already excited, as was described by Mr. Canton in the Philosophical Transactions.

No experiment shews the facility with which magnetism may be induced in a piece of soft iron by the earth's magnetism alone, more simply or beautifully than that which was exhibited before the Royal Society, by Mr. Hindshaw, in 1673. It consists in placing a small sensible compass near the edge of a table, when it will soon rest in the direction of the magnetic meridian of the place. A poker, or any bar of soft iron which possesses no magnetism (which is easily ascertained by trying whether its ends will indifferently attract either end of the compass), is now to be held in an angle of about 72° with the horizon, and at the same time sloped in the direction of the magnetic meridian, when, upon bringing either of its ends near the compass, it will be found to possess polarity, and its lowest end will attract the south end of the needle only, and repel the opposite one; and in moving the bar of iron downwards in a direction parallel to its first situation, until its upper end comes near the compass, this will be found possessing a southern polarity, and will attract the north end of the compass only, and repel the other. But keeping the upper end in its last position near the compass, and moving the lower end round it as a pivot in a semicircular direction until its lower end arrives in that situation where the upper end formerly was, the polarity of the bar will be instantly changed, for the end near the compass, which but just before would attract the N. end of the needle only, will now repel it, and attract the S. end; so that a mere change of position completely reverses all the magnetic effects.

The same influence which thus causes a transitory polarity in the bar of iron, also causes the suspended magnet or needle to dispose itself whenever it rests in the direction of the earth's magnetic axis and poles; and these, as has been before observed, are at no very great distance from the N. and S. poles, upon which the earth revolves; but when, and by whom, this circumstance was applied to the purposes of navigation, is involved in much doubt. Dr. William Gilbert, a physician at Colchester, who, notwithstanding he wrote in the 16th century, was a strenuous advocate for the inductive mode of reasoning in philosophical matters, which was so happily introduced by the great Lord

Bacon, and who investigated every circumstance connected with magnetism with a degree of zeal and success, hardly to be expected at so early a period, ascribes the first application of the magnet to the purposes of navigation in Europe, to Flavio, or John de Gioja or Giova, a Neapolitan, who, he says, used it in the Mediterranean sea in the 13th century. Paul the Venetian is said to have brought the invention of the compass from China to Italy in 1260. The first compasses used are supposed to have been pieces of loadstone, floated by means of cork or light wood upon the surface of water contained in a dish, on the bottom of which the cardinal points of the compass were marked; indeed, our modern name, *loadstone*, which is perhaps more properly *lodestone*, seems to be derived from the Saxon Lode, signifying to lead or direct; indicating that this stone, also more anciently called *lapis nauticus*, was used to steer by, antecedent to the invention of the artificial steel magnets now universally adopted.

Du Halde, in his history of China, adduces some evidence to show that the compass was known and used in that country as early as the 22d cycle, or 1040 years before Christ; and the observation of Sir George Staunton, in the Account of his Embassy to China, that the magnet is one of the attributes of their Neptune, and is placed in one of the hands of the idol, is not a little curious.

The application of the compass to the purpose of directing a ship's course on the ocean, is so simple as to need but little explanation. It must always be used in conjunction with maps, charts, or a previous knowledge of the situation of the country; and since the compass needle will always point in one direction, viz. nearly N. and S. notwithstanding any motion the vessel may have which contains it; so, by knowing the latitude and longitude of the ship, its place on the map becomes identified; and the bearing or angle which the place she is sailing towards makes at that point with the meridian, can be ascertained; when the vessel by steering accordingly, may be made to move in the same angle with respect to her compass; and thus will reach her port of destination with certainty. For the purpose of adjusting this coincidence with accuracy, the outer circle of the compass is always divided into 360 degrees, and the compass is carefully hung on centres called gimbals, with its centre

of gravity much below the points of suspension, to prevent the motion of the ship from affecting it.

In this manner the compass was used during the 14th and 15th centuries, without any suspicion or apprehension of its pointing otherwise than truly towards the N. and S. poles of the earth, until the 13th of September, 1492, when Christopher Columbus, in his first voyage in search of the western continent, and just one month before he had discovered it, perceived that his compass was not to be implicitly relied on, but that it varied half a point, or nearly 6 degrees to the east of the north, as ascertained by astronomical observation; and on the following day he found this deviation from truth amounted to a whole point. Being much surprised at this circumstance, which had never before been observed or noticed, he watched it minutely, and found that, as he proceeded, the needle returned to its true situation; but on advancing about 100 leagues further to the west, it varied again in a contrary direction; it now pointing nearly a whole point to the west of the north.

This deviation, or variation of the compass, as it is now called, from the true N. and S. points, was at first supposed to be accidental, and to depend upon the imperfect construction of the compass, until 1497, when Sebastian Cabot discovered that every needle had the same quantity of variation in the same place at any one time, but that the variation was different in distant countries. Still however it was not suspected that this variation was itself changeable in the same place at different periods, until this fact was also ascertained by Mr. Gellibrand, one of the Professors of Gresham College, who having had his attention directed to the subject, made a number of very accurate experiments during several years, with a very perfectly constructed magnetic needle, three feet in length, which he observed by comparing it with a fixed meridian mark, and he then found that the declination or variation itself was not constant, but increased from the E. towards the W. so that between June 1665, and the same month in the following year, the needle had moved 13 minutes 6 seconds nearer to the W. than it was before; and by accurate observations which have been continued ever since, it is found that the variation is progressive, and constantly changing.

At the time of Mr. Gellibrand's observations, the needle

at London pointed very nearly in the direction of the meridian; but the deviation which then existed was to the west of it, as it is at present: but when the variation was first observed, it was considerably to the east, while in 1657 there was no variation whatever in London, but the needle pointed due N. and S; it then changed into western variation, which has progressively increased ever since, and now amounts to about 24° 36′; and accordingly in setting any instrument in the meridian by means of a compass, this quantity of western variation must be allowed for. Notwithstanding the quantity of variation thus increases; yet it does not do so by equal quantities in equal times, for during the latter years, a very trifling increase of variation has occurred, as will appear by inspection of the following table, extracted from the authorities of Norman, Burroughs, Gunter, Gellibrand, Cavallo, Beaufoy, and personal observation.

of ...tion	'ariation, or angle of deviatioı from the true meridian of London.
576	11° 15′ East.
580	11 11 E.
622	6 0 E.
634	4 5 E.
657	No variation at London.
665	1 22 West.
67	2 30 W.
683	4 30 W.
692	6 0 W.
.700	8 0 W.
1717	10 42 W.
1725	11 56 W.
1730	13 0 W.
174	15 40 W.
1750	17 54 W.
176	19 12 W.
177	20 35 W.
178	22 10 W.
179	23 34 W.
180	24 7 W.
181	24 19 W.
181	24 29 W.
181	24 36 W.

From the very small advances which the needle has made westward for several years past, it has been expected that its western variation was arrived at its maximum, and that after remaining stationary for some period, it would commence a retrograde motion. It has been pretty generally stated that this retrogradation is already begun; but although there is very little doubt that the needle has reached its greatest western limit, and will gradually return again, yet, for reasons which will presently appear, it is almost impossible to say unequivocally that this is the case.

The cause of the variation of the compass, or its declination from the true meridian, and, why that declination should be different in various parts of the world, admits of easy explanation; but why the quantity of variation should change in the same place, and how this change is brought about, are questions

which have never yet been expounded, and which have hitherto proved superior to the very eminent talents which have been exerted in their development.

That the needle cannot point to the true north pole of the earth, is evident upon the common principles of magnetism; for since the earth's magnetic poles do not coincide with its revolving poles, through which all meridians must pass, of course all needles will point to the magnetic instead of the revolving poles, and will thus make a different angle with every meridian, except only that single meridian which happens to pass through the magnetic pole; and as this meridian will pass in common both through the magnetic and revolving poles, there can be no variation upon it; for the needle, in pointing to the magnetic pole, will point also to the real pole at the same time. The above account is however merely assumed for the sake of explanation; for in consequence of some unknown disturbing cause, the magnetism of the earth is so unequally diffused, with regard to its surface, that no meridian exists, upon which there is no variation at all from north to south; but the line of no variation takes a curved direction which will be afterwards noticed.

Admitting, however, that the variation of the compass is occasioned by a want of coincidence in situation between the revolving and magnetic poles, which certainly is the case, yet if these magnetic poles were permanently fixed to one situation upon the earth, and without motion, whatever variation was thus occasioned in any one place, ought invariably to remain the same, which is not found to be the case; consequently the magnetic poles are not so fixed, but must have motion. Their change of place is however so slow, that the effect of variation has not yet been discovered a sufficient number of years to know what the nature of this motion really is; but looking at the changes in variation which have taken place in successive years, as given in the above table, it appears as if the north magnetic pole of the earth was performing a slow revolution round the earth's real north pole, and that now being at its greatest elongation from that pole, it is either receding from, or approaching towards us in an almost right line, in conse-

quence of which the needle remains stationary, and must continue so to do, if this is the case, for several years, or at least until the magnetic pole is so far advanced in that revolution as to forsake its right lined direction, which, together with the difficulty of observing minutes on account of the diurnal variation, not yet mentioned, may accoûnt for no decisive retrogradation having yet been observed.

On recurring to the observations contained in the table, it appears, that from 1576, when the variation seems to have been first accurately noticed, until 1657, being a period of 81 years, it diminished from 11° 15′ to nothing; and that from 1657 to the present year, being very nearly double the first period, or 161 years, the variation is rather more than doubled, being 24¼ degrees. It seems therefore as if the periods of increase and decrease were nearly equal, and if so, that the north magnetic pole requires about 644 years to revolve round the earth's north pole. Should this be the case, in 161 years more, or about 1979, another quarter of its orbit will be performed, and the line of no variation may again pass Great Britain. But since the observations which have been made, do not altogether include an entire traverse of the needle, and there is no evidence that the eastern variation may have the same limit as the western, it is impossible to come to any determination on this subject.

Among the persons who have most conspicuously interested themselves in developing the intricate phenomena of magnetic variation, Dr. Edmund Halley stands preeminent, He first introduced the importance of this subject to the British Government, and obtained a ship to be sent out for the express purpose of making observations and discoveries. In this he repeatedly traversed the Atlantic ocean, proceeding as far as the 50th degree of south latitude; and an account of his laborious exertions and curious and interesting speculations made during this voyage, will be found in the Philosophical Transactions for 1683 and 1692. After having collected a prodigious number of observations on the variation of the compass at the different points he passed, and registered them on a large map of the

world, he united all those places which either had no variation, or equal quantities of it, East and West, by drawing lines through them; and in this way first proved the extraordinary irregularity of the lines of similar variation, which, instead of being straight, and according with the meridians or parallels of latitude on the earth, seemed to have no reference to them, but formed curves, intersecting them in all directions. These he published in the form of a sea chart in 1700, and they met with that approbation from the public, which so novel and laborious a work justly merited. He was however much disappointed at the general result of his labours, for he imagined before embarking upon them, that by obtaining such charts, he should have been able to have traced some system in the lines of variation, or have been able to have obtained the elements of which they were formed, so as to have enabled him to form some permanent laws, or, at any rate, a rational hypothesis to account for magnetic variation. The curves his observations produced were however so irregular, and so unlike any thing which could be made matter of mathematical investigation or calculation, that he was obliged to confess himself unable do discover any general principle by which the changes in magnetism could be connected or explained.

From the changes which are constantly going on in the magnetism of the earth, Dr. Halley's charts became so erroneous as to be almost useless within 50 years after they were published; but their great utility to navigators, while they could be depended on, was such as to induce two gentlemen, Messrs. Mountain and Dodson, to revise and republish them; which they did, adjusting and correcting them so as to answer for the period between the years 1745 and 1756; and for this purpose application was made to the Admiralty, and all the great trading companies, for permission to inspect their records, and observations upon variation, by which means the results of upwards of 50,000 observations were introduced into these charts.

Notwithstanding the great interest and pains which appear to have been taken to subject terrestrial magnetism to some

definitive laws, about the end of the 17th and beginning of the 18th century, yet since that period this subject seems to have been almost wholly neglected. Whether this may have arisen from the fear, that if the transcendant abilities of a Halley could not accomplish the task, it was in vain for others to attempt it, or from what other cause it is impossible to say, but no grand national attempt has since been made, except only, the expedition which has lately sailed towards the north pole, one of the leading objects of which is to ascertain, if possible, the situation of the earth's north magnetic pole.

From the observations which Dr. Halley made, he was at first induced to conclude that this pole was situated in or near Baffin's bay, and that the south magnetic pole was somewhere to the S.W. of New Zealand; but he afterwards ascertained that he could not find any position for the two poles which would produce the effects which he observed in the needle in different parts of the world. This induced him to adopt the supposition that the earth, instead of having but two magnetic poles, had four, a circumstance which is by no means uncommon in magnets, and may be produced artificially at any time in a piece of steel.

He imagined that these poles were not all of equal strength, but that one pair was stronger than the other, and that every needle would be acted upon by that pole to which it was the nearest. The pole which he presumes governs Europe, Tartary and the north sea, he places in the meridian of the Land's End, about 7° from the north pole of the earth. The second north magnetic pole he places in the meridian of California, 15° from the north pole, and this he supposes governs the needles of America and the oceans on either side of it; the southern variations he accounts for by an almost similar arrangement in the southern hemisphere, the particulars of which will be found detailed in the Phil. Trans. No. 148. Such an arrangement could however produce only an irregularity in the magnetic curves and effects in various parts of the world, but would be incapable of explaining why the quantity of variation should change with time in the same place. To accommodate his hypothesis to this fact, he proceeds to state, that while one

pair of magnetic poles are constantly fixed to the same situations on the earth, the other pair are moveable round them; and the better to explain this motion, he imagines that the earth contains a revolving magnetic nucleus having two poles, which in their motion either assist or diminish the power of the two fixed magnetic poles of the earth.

Next to the attempt of Dr. Halley to investigate the phenomena of terrestrial magnetism, may be mentioned that of Mr. Euler, who has spared no pains on this subject, and has reduced it to great apparent simplicity, though unfortunately by working in a great measure upon assumed, rather than ascertained principles: he contends that all the varieties in the direction of the earth's magnetism may be produced by two poles only, one of which he places for the year 1757 in latitude north 76 and long. 96 West, and the other in latitude south 58 and long. 158 West of Teneriffe in both cases. The general course of variation which he pointed out by virtue of this hypothesis was found to correspond pretty nearly with nature; but the tables and charts which he afterwards published were never sufficiently accurate to be of use to the navigator; arising perhaps in a great measure from his want of a sufficient number of well authenticated observations.

From the time of Euler, it does not appear that any one has entered zealously upon the subject of magnetic variation until 1794, when a work by Mr. Churchman appeared, under the title of the Magnetic Atlas, but which he professed to say was only the programme of a more extensive work which he meant to publish, in the event of his first essay meeting sufficient encouragement from the public to induce him to complete it. The second part has not however appeared. Mr. Churchman having been a practical navigator, appears to have been in possession of many facts, which he applies to the formation of a theory of magnetism on the principles of Euler, though with less science and penetration; and notwithstanding so little is known of magnetism, yet he pretends with great confidence to predict the situation of the magnetic poles for many years to come.

He places the north magnetic pole in lat. 58° north and

long. 134° west, and the south magnetic pole in lat. 58° south and long. 165° east of Greenwich, for the year 1794. He conceives the magnetic meridians (notwithstanding the authority of Dr. Halley to the contrary) to be great circles passing through the magnetic poles; but the magnetic equator, he says, is not a great circle, it being nearer to the north than the south pole. The north magnetic pole he asserts had moved 65° eastward in the same parallel of latitude between the years 1600 and 1794; from which he concludes that it is advancing in a circular orbit round the north pole of the earth at the rate of 19′ 42″ 29‴ of longitude annually, consequently it will complete its revolution in 1096 years; and upon the presumption of this motion, he calculates the place of the north magnetic pole, even to minutes, from the years 1600 to 1900, inclusive. The south magnetic pole, he says, does not move round the south pole of the earth with the same rapidity, since it requires 2289 years to complete its revolution; and he ascribes these separate motions of the poles to some general magnetic influence in the universe, producing a species of magnetic tide. Mr. Churchman appears throughout to have too much confidence in the infallibility of his own theory; for although it may be made to agree with the variations which occur in many places on the earth, yet by far the greater number of them are made to have too much or too small a variation; and the magnetic influence is pretty well ascertained not to act in lines at all approximating to the forms he assigns to them.

The little success which has hitherto attended all the attempts to reduce the effects of magnetism to any thing like certain laws, ought not however to deter others from embarking in the same great cause; and although the subject is involved in much difficulty, from the necessity of obtaining and comparing observations made in all parts of the world, yet it is only by reiterated attempts, and by cautiously avoiding the errors which experience points out that others have fallen into, that we may hope at last to surmount all obstacles. Among the latter persons who have given their attention to this subject, is M. Biot, who in the 3rd vol. of his *Traité de Physique*,

published at Paris in 1816, has given a most valuable dissertation on this subject.—M. Biot, from considering the difficulties which have always attended the discovery of the true situations of the earth's magnetic poles by actual experiment, on account of the ice with which they are always enveloped, directs his attention to the magnetic equator, on the supposition that if it is a great circle of the earth, the magnetic poles will be points equidistant on all sides above and below it. The magnetic equator may be found at any time by means of the dipping needle; it being that neutral line between the poles in which the needle will maintain its horizontal position. From an examination of the observations of La Perouse, Bayly, La Caille and Humbolt, made in different parts of the world, he finds that the inclination of the magnetic equator to the real equator of the earth, is at a mean 12° 5′, and that one of the nodes or crossing places is in long. 115° 34′ west of Paris. But Capt. Cook and Bayly, while in the South Sea in 1777, and in separate vessels, both found the magnetic equator in south lat. 3° 13′ at the longitude of 158° 50′ W., while by prolonging the line obtained from the first mentioned observations in its rectilineal direction, it would have extended to 8° 36′ of north latitude at the same longitude, which shews at once that the magnetic equator cannot be a great circle in a plane, but that it must be bent or inflected; and M. Biot, after a laborious investigation, which could not be done justice to in this cursory report, already extended beyond the limits which were originally proposed, determines that the magnetic equator is so bent out of its plane, as to pass twice above or to the north, and twice below or to the south of the equator of the earth; thus having four nodes instead of two, as originally supposed. The disturbing cause which produces the secondary elevation, which is much smaller than the principal one, appears to exist somewhere about the Archipelago of the Pacific ocean. The situation which he assigns to the north magnetic pole, is lat. 78° N. long. 25° W. and to the south magnetic pole, lat. 78° S. long. 205° W.; and he imagines that the same disturbing cause which affects the regularity of the magnetic equator, will also produce many of those anomalies and irregularities which are

met with in the variation of the compass in different parts of the globe.

One of the circumstances which adds to the uncertainty of magnetic observations, and indeed is one cause why it is yet impossible to say that the needle has began its retrogradation towards the East, is its diurnal variation, an effect which has not yet been mentioned or described. The needle, however, not only has the general variation of about $24\frac{1}{2}$ degrees to the West, but this is subject to a daily augmentation and diminution of several minutes, which precludes the possibility of saying what the precise situation of the needle is to within a few minutes at any given time, except by taking a mean of its motions. Thus in stating that the present variation at London is 24° 36′ West, it must be understood to express mean variation, since at some times in the present year, the needle has been as much as 24° 42′ West, and at others only 24° 30′, varying as much as 12 minutes with particular days and seasons; consequently the mean of these motions would be 24° 36′, which was taken. This diurnal variation was first noticed and laid before the Royal Society by Mr. Graham in 1722; and having been very accurately observed ever since that period, is found not only to be very regular, but to be dependant on particular seasons, and times of the day; insomuch that it is generally thought to be occasioned either by solar light or heat, or perhaps the joint influence of the two; for the quantity of variation is found to be least in the morning of each day; it increases to its maximum towards the middle of the day, and again declines into its morning position as the cold of night comes on. Its quantity is also affected by the seasons, since it is greatest in the summer months, and least in those of winter; the greatest difference between mid-day and mid-night in the winter months seldom exceeding 4 or 5 minutes, while that of the summer months frequently amounts to 9 or 10 minutes.

The results above mentioned, which are uniformly obtained, cannot fail to shew a connection existing between solar influence, and the magnetism of the earth; but how this exists and is carried on, has never been determined. Mr. Canton, who paid considerable attention to this subject, was of opinion,

that heat alone was the cause which produced the effect of diurnal variation, and he endeavoured to confirm his views by experiments on heating magnets in various ways, which he found diminished their power or intensity; and thus he thought that the intensity of the earth's magnetism was diminished by solar heat. Such a cause, however, does not alone appear sufficient to produce diurnal variation, because as the north magnetic pole is situated in a part of the earth upon which the sun shines unceasingly for many weeks together, it does not appear probable that this constant action should produce the mutable effects which are known to accompany diurnal variation. Light may, in all probability, be found at some future time to be a more direct agent in the production of these effects than is expected; an idea which is amply supported by the late experiments of Moricchini, and the Marquis Ridolfi, as detailed in this Journal,* and by which it appears that they succeeded in magnetizing needles, by simply exposing them to the violet ray of the sun, as produced by a prism, for a period not much exceeding half an hour. If such experiments as these do not prove that magnetism resides in the solar ray, or is identical with it, they show at least, that it is capable of inducing, or exciting it to action; and they almost prevent the trouble of a further search into the cause of the earth's magnetism, for that which can excite in one body, may be reasonaby expected to produce a similar action in others. Perhaps the very action of light upon the earth's surface, may produce that change in the magnetic variation, which has hitherto remained unaccounted for. One of the most ingenious accounts of the cause of this variation is that of Dr. Lorimer, prefixed to the end of Cavallo's treatise on magnetism; but in which he follows Mr. Canton, in supposing solar heat alone to be the cause of the general change, as well as of diurnal variation. The leading features of his opinion are, that as the eastern part of the globe is always first addressed to the sun in the morning, and becomes heated, by this means its magnetism is diminished; while the western part, yet cold,

---

* Vol. III. p. 406, and vol. V. p. 138.

remains in its natural state, and relatively stronger than that which has been diminished; the needle will of course incline, or vary towards the West. But as the western hemisphere in its turn comes before the sun, and is heated, its magnetic power will in like manner be diminished, while the eastern side cools, and has its power restored: which of course brings the needle back towards evening into its former situation. The magnetic poles must therefore perform a daily revolution, proportional to the variation produced; and as the sun's power will be greatest soon after the pole has come before him, and least in the opposite direction, the forces tending to move that pole, will be unequal; consequently, the orbit described may be presumed to be of an elliptical form. But as the earth, while making one revolution, moves in its orbit with respect to the sun, there will not be a force at the end of one diurnal revolution to bring the pole back, equal to that which removed it, so that it will not return to the very same point again; and thus will the north magnetic pole be carried gradually and constantly towards the East, while a similar but opposite process will be going on at the south pole.

But of all the observations which have been made on the magnetism of the earth, those of Capt. Flinders promise to be of the greatest practical utility. The circumstances which he has pointed out, it is true, did not originate with himself to a sufficient degree to entitle him to be called their discoverer, yet the applications which, by laborious investigation, he has made of principles which, although known, appear to have been regarded as of little or no importance, and the highly useful result of his labours, entitle him to his country's warmest gratitude. Indeed the anomalies and want of concordance among all the magnetic observations which had been made antecedent to his researches, may in a great measure be traced to the want of that knowledge which he first gave to the world. This consisted solely in a due consideration of the situation of the compass at the time of using it, how far it might be affected by its proximity to ferruginous matter, and how far that matter might have its own magnetic energies affected by induced

magnetism, produced by its relative position to the magnetism of the earth.

It had always been customary to obtain the variation of the compass at sea, by means of celestial observation, without any regard to the position of the ship, the direction in which she was sailing, or even the situation of the compass which was to be examined; and it is well known, that even the nicest observers and most experienced navigators were frequently placed in a state of uncertainty, by obtaining different quantities of variation even at the same place, and sometimes at nearly the same time, the difference in some cases amounting to only a few minutes, while in others it would be several degrees. This want of accuracy was generally imputed to the imperfect construction of the compass; such as having too much friction on its center, or its needle not having been well magnetised. But Capt. Flinders has shewn that it depended on another cause, which was not even suspected.

Notwithstanding such inaccuracies in the compass must have been long known, yet the first person who appears to have paid any serious attention to them, was that excellent astronomer, Mr. Wales, who accompanied Capt. Cook, and who in the introduction to the second and third voyages, has published some valuable observations on the subject. He states, that while in the English Channel he met a difference of variation of from 19° 30′ to 25°, and that all the way to the Cape of Good Hope he met with differences nearly as great, without being able in any way to account for them, the difference in situation being by no means sufficient. He therefore determined to consider seriously all the circumstances under which these observations had been made; and he then discovered, that the greatest variation had always occurred when the ship's head was north and easterly, and the least when it was south and westerly. Captain Cook and some of the officers were apprized of this circumstance, but as they did not appear to think it of much importance, the investigation was not pursued. Mr. Wales was however pursuaded that during the whole voyage, those variations which were taken with the ship's head in different posi-

tions, or even with the compass in different parts of the vessel, varied very materially from each other, a circumstance which he afterwards confirmed and verified by comparing his own observations made in the Adventure, with those which were made about the same time in the Resolution.

Mr. Wales also proceeds to state some experiments which prove the truth of his assumptions; such as that putting a ship's head in a contrary direction, will produce a difference of from three to ten degrees, and several others of equal importance.

Captain Flinders, in his voyage to Terra Australis, undertaken during the years 1801, 2, and 3, in the ship Investigator, found the same perplexing want of coincidence which had occurred to Mr. Wales, which determined him to institute an inquiry into its cause. He began by ascertaining that observations taken with compasses in differents parts of the same ship, even while it was stationary, did not agree, there being a difference of four degrees and a half less in the observation taken upon the booms, before the main mast, than in that at the binnacle; consequently that the compass should always be used in the same part of the ship. But this precaution was not sufficient, for a change in the direction of the ship's head always made a difference in the pointing of the needle. The nature and quantity of this difference could not be obtained until a vast number of observations had been made; and when these were procured, they shewed clearly that when the ship's head was on the east side of the meridian, the differences were one way, but that when the head of the ship was turned to the west, they were the other. This induced him to judge that the iron necessarily used in the construction of a ship, attracted the needle and drew it out of its course, not by its immediate attraction as simple iron, but by its becoming magnetic by induction from the earth's magnetism underneath it, and consequently acting with varying force upon the compass, as the ship itself was placed in one situation or another, with respect to the earth's magnetic meridian; and he had the satisfaction of proving the truth of this assumption, by all the experiments and observations he afterwards made in the course of his

voyage. One instance which he gives, among many, will be sufficient to show the immense importance which a knowledge of these facts must be of to all those who are concerned in the conducting of vessels at sea. The ship being off the Start Point, was placed with its keel in the direction of the magnetic meridian by a good compass, and with its head to the north: the variation being taken in this position by astronomical observation, was found to be 25° 30′ west; the ship's head was now put round to the west, when the north end of the needle was drawn nearly four degrees out of its former position, thereby increasing the apparent western variation to 29° 30′: the ship's head being now carried round until it stood due south, the four degrees of increased variation gradually decreased, and the needle once more returned to 25° 30′; but on putting the head of the ship to due east, a diminution of variation occurred also equal to four degrees, making the total variation now appear to be but 21° 30′, or eight degress less than it appeared to be when the head was towards the west. On bringing the head again to the north, the original or correct variation again occurred, because now the whole length of the ship, and consequently all the iron contained in it, was in the immediate direction of the magnetic meridian. Results, similar in nature to the above, were obtained throughout the whole voyage; and while the north end of the needle was found to be affected in the northern hemisphere, so was its south end equally affected in the southern.

From these experiments it appears, that the only time when correct observations can be taken on magnetic variation, is when the keel of the vessel coincides with the magnetic meridian; or at any rate, they should all be taken when the head of the vessel is at similar angles east or west from that meridian. Captain Flinders further found, that the quantity of error in variation was greater in high than in low latitudes, and yet did not increase or diminish in any apparent ratio with the latitudes. And it was not until he had undergone a laborious and minute investigation of his numerous observations, that he discovered that the errors had a close connection with the dip of the needle, and that when the north end of the needle

dipped, it was the north end of the compass which was attracted by the iron in the ship; that as the quantity of dip diminished, so did that attraction; while on proceeding into the southern hemisphere, when the south end of the dipping needle was depressed, the errors again occurred, and increased with an increasing dip, but in a contrary direction to that which they before had; for in the southern hemisphere the western variations appeared too great when the ship's head was to the eastward, though it still was without error when the ship stood due north and south. These circumstances evidently proved a coincidence between the quantity of dip and quantity of variation; and after maturely considering the subject, he found himself justified, by his observations, in taking the dip of the needle as a basis upon which he could compute its variation; and from a chain of reasoning which could not be done justice to in the present place, he proposed the following rule, which he tried in a great number of instances, and found the results to correspond as nearly as could be expected, and in some cases exactly. His rule is, that the error produced at any direction of the ship's head, is to the error at east or west at the same dip, as the sine of the angle between the ship's head and the magnetic meridian is to the sine of eight points of the compass, or the radius. On Captain Flinders' return to England, he made application to the Lords Commissioners of the Admiralty, to have some experiments tried near home, for the purpose of verifying his conclusions; and accordingly a series of observations were instituted on board of five of His Majesty's ships at Sheerness and Portsmouth, the result of which was, that the truth of his observations, and the accuracy of the deductions he made from them, became fully established.*

What has been already stated, is sufficient to show the great importance of this newly acquired knowledge; for as it is

* Those who may wish for further information on this important subject, we must refer to the published voyage of Capt. Flinders, or to a most valuable little work, from the practical information it contains, entitled "An Essay on the Variation of the Compass, by William Bain, Master in the Royal Navy," one vol. octavo, published at Edinburgh, and in London, by Murray, in 1817.—This latter work was reviewed, and copious extracts give from it in this Journal, vol. iv. p. 102.

customary, particularly in small trading vessels, to observe the direction of their course by the compass when they leave a port, and on returning, to take the precisely opposite course; the above facts will demonstrate the incorrectness of such proceeding, unless their voyage happens to lay very nearly in the direction of a magnetic meridian, or north and south. In proceeding in an easterly and westerly direction, they must be grossly deceived by so steering; and there is very little doubt that many ships, with valuable lives and cargoes, have been lost, from a want of the knowledge of this circumstance.

The foregoing account may serve to give a general outline of the information which was conveyed in this Course of Lectures, the immediate object of which, was to bring into one focus all the leading facts which are known concerning that subtile, but powerful agent of nature, magnetism, and to point out the necessity and importance of its further investigation; for after all that has hitherto been done in it, it must be confessed that its intimate nature is by no means understood. Its relationship to light has already been noticed, and in many instances it seems equally allied to electricity; but still there is no evidence to prove that they are the same; and even the link which connects them, if they are connected, appears to be wanting. The circumstance which bespeaks the most intimate connection between magnetism and electricity, is, that the aurora borealis has a constant influence on the magnetic needle. When that has been observed to be flashing with brilliancy nearly over the north pole of the earth, the needle, even in Great Britain, has been agitated and put into a state of vibration, frequently amounting to several degrees on either side of its stationary point, which indicates how sensibly the magnetism of the earth must be affected by this phenomenon.

All the experiments, however, which have been tried to establish a connection between magnetism and electricity produced by artificial means, have proved futile; and notwithstanding Mr. Ritter, in a communication to the Royal Academy of Sciences at Munich, seems to have established a species of closer connection, than had before been proved, yet his experiments appear as if they would not stand the test of repetition;

if they do, they will be made the subject of future Lectures and further discussion at this place. Mr. Millington concluded his Course, by strongly pressing the necessity of making magnetic observations in the most careful manner in all parts of the world, and publishing them in the various Journals or works of Science, with as much regularity as the meteorological tables which are usually given, and recommended the form and manner adopted by Colonel Beaufoy, in the Annals of Philosophy, to whom many thanks are due for the regularity and correctness of his magnetic observations. Such observations, if made at sea, ought to be accompanied by the direction of the ship's head;* and if such a general publication could be established, the public would in the course of a few years be put into possession of the state of the magnetic variation throughout the world, without the expense of its investigation by any particular nation, and the most beneficial results might ensue.

From the length of our present Report, we are prevented giving any account of Professor Millington's succeeding Courses of Lectures on Electricity, and the Power of Wind and Steam, with an account of the invention and progress of the Steam Engine, which must be resumed in a future Number.

Art. XII. *Letter from* Sir Everard Home, *Bart. to Mr.* Brande, *on the Use of Colchicum.*

My Dear Sir,

In the communications which I made to the Royal Society, upon the use of the Vinum Colchici in gout, in the year 1817, I was desirous of putting an end to the quackery respecting that medicine, and to restore it to the place it held in the pharmacopœia in the time of the Greek physicians; at the same time that I explained an improvement in its preparation,

* An error or difference of nearly 30 degrees appears to have occurred by a change of direction of the ship's head in high northern latitude; see a letter from the present Arctic Expedition, in Morning Chronicle, Friday, 18th of September, 1818.

from which I have myself received so much benefit, that I was desirous of giving my fellow sufferers an opportunity of partaking of it.

The Philosophical Transactions being a work set aside for investigations, and recording new facts, not for practical essays, I contented myself with stating what was new, leaving to the practitioners in medicine to put my observations to the test, and diffuse the benefits of this mode of employing the medicine.

I am now induced, by the numerous applications that are made to me for further information on the subject, to send the following observations to you, with a request that you will give them a place in the Journal of the Royal Institution, by which means they will be more generally diffused than through the medium of the Philosophical Transactions.

It is not now necessary to discuss the point, whether there is any difference between Husson's and Wilson's gout medicines and the Vinum Colchici, since they all three cure the gout nearly in the same dose, and the same period of time; proofs of their identity sufficient for any practical purpose.

The facts on which I wish to lay particular stress are the following:

1st. That the Vinum Colchici, when received into the circulation in small doses, produces no deleterious effects, and only brings on the same symptoms as when taken into the stomach, which go off in similar periods of time.

2nd. That the deposit which is separated from the infusion by keeping, when given by itself in the dose of a few grains, produces inflammation and ulceration on the coats of the stomach and intestines.

3d. That the infusion removes the paroxysm of gout equally readily, whether given without the deposit, as with it.

4th. The infusion, when clear of the deposit, can be taken in doses of 60 or 70 minims, without producing any disturbance in the stomach, increasing any of the secretions, or bringing on an irregularity of the pulse, effects which commonly occur when that dose is given with the deposit mixed with it.

5th. That 60 minims is the smallest dose that can be depended upon for the complete removal of a paroxysm of gout.

These are the facts which I communicated to the Royal Society, and which are confirmed by an experience of 17 months upon myself and many other individuals. In some constitutions, a dose of 70 minims may be required, and that dose I know can be taken with safety, as I have taken it myself, and found no sensible effect from it, further than a slight nausea, and that the attack of gout was carried off.

The advantage of taking the Colchicum in this form is, that being milder, the dose necessary for the cure can always be employed without injury to the stomach, even in states of the greatest debility. After an illness, by which I was reduced to so great a degree of weakness as to be unable to walk alone, the gout came violently in my left foot; 60 minims of the Vinum Colchici completely removed it in 24 hours, without any disturbance being produced in the stomach, or any other distress whatever. The consequences of a violent fit of the gout under such circumstances, had it been allowed to go on, are not to be calculated.

As 60 minims of Husson's and Wilson's medicine too often produce purging to a violent degree, in all such cases it must be given in reduced doses; and as a smaller does not produce a cure, unless repeated; the stomach, by such repetition, is not only more disturbed, but kept a longer time in that state, and the disease not so effectually removed; and it is known that in all constitutions liable to gout, whatever deranges the stomach, tends to bring on the paroxysm.

The Vinum Colchici, without the deposit, has another advantage, for as it does not irritate the stomach, it does not require being compounded with other medicines, to defend the stomach from its effects, so that the patient can measure out the dose for himself, which he will take more pains to do accurately, than any other person; and here great accuracy is necessary.

The bulbs of the Colchicum should be collected after the disappearance of the leaves, which happen in July, and before the appearance of the flower, early in September.

EVERARD HOME.

Art. XIII. *On the Production of Gas for Illumination, from Oil.*

Except in the first application of prepared gas to the economical purpose of procuring artificial light, there is, perhaps, nothing in that branch of applied science which holds out such fair prospects as the use of oil in its formation. Without being more expensive than the gases that have already been prepared from coal, tar, and other substances, it offers every use and convenience they have; in some respects, superiorities; and it effectually prevents the undue influence of a monopolizing spirit, which would originate in the necessity of large establishments, or the difficulty and trouble of small ones.

Messrs. J. and P. Taylor are the first persons who have resorted to oil as a substance from which gas for illumination could be easily and cheaply prepared; and in the construction of a convenient apparatus for the decomposition of this body, they have fully shewn its numerous advantages over coal, while they have afforded the means of producing the most pure and brilliant flame from the inferior and cheap oils, which could not be used in lamps. The apparatus for the purpose is much smaller, much simpler, and yet equally effectual, with the best coal gas apparatus. The retort is a bent cast iron tube, which is heated red by a small convenient furnace, and into which oil is allowed to drop by a very ingenious apparatus; the oil is immediately volatilized, and the vapour in traversing the tube becomes perfectly decomposed. A mixture of inflammable gases, which contains a great proportion of olefiant gas passes off; it is washed by being passed through a vessel of water (which dissolves a little sebacic acid, and which seldom requires changing), and is then conducted into the gasometer.

The facility and cleanliness with which gas is prepared from oil in the above manner, may be conceived from the description of the process. A small furnace is lighted, and a sufficient quantity of the commonest oil is put into a small iron vessel, a cock is turned, and the gas after passing through water in

the washing vessel, goes into the gasometer. The operation may be stopped by shutting off the oil, or, to a certain extent, hastened by letting it on more freely; the small *quantity of* charcoal deposited in the retort is drawn out by a small rake, and the water of the washer is very rarely changed.

The gas prepared from oil is very superior in quality to that from coal; it cannot possibly contain sulphuretted hydrogen, or any extraneous substance; it gives a much brighter and denser flame; and it is also more effectual, i.e. a lesser quantity will supply the burner with fuel. These peculiarities are occasioned, in the first place, by the absence of sulphur from oil, and then by the gas containing more carbon in solution. As the proportion of light given out by the flame of a gaseous compound of carbon and hydrogen, is in common circumstances in proportion to the quantity of carbon present, it is evident that the gas which contains a greater proportion of olefiant gas, or supercarburetted hydrogen than coal gas, will yield a better and brighter light on combustion.

It is necessary, in consequence of the abundance of charcoal in solution, to supply the gas when burning with plenty of atmospheric air, for as there is more combustible matter in a certain volume of it, than in an equal volume of coal gas, it of necessity must have more oxygen for its consumption. The consequence is, that less gas must be burnt in a flame of equal size, which will still possess superior brilliancy; that less is necessary for the same purpose of illumination; and that less heat will be occasioned. From 5½ to 6 cubical feet of coal gas are required to supply an Argand burner for an hour; 2 cubical feet to 2½ of that from oil, are abundantly sufficient for the same purpose.

One important advantage gained by the circumstance, that so small a quantity of this gas is necessary for burners is, that the gasometer required may be small in proportion. The gasometer is the most bulky part of a gas apparatus, and that least capable of concentration; and wherever it is placed, it occupies room to the exclusion of every thing else. Some very ingenious attempts have been made to diminish its size and weight, as in the double gasometer, and others, but without

remarkable success. Here, however, where the room required to contain the gas is directly diminished, the object is so far obtained; and when that takes place to one half, or even one third, it is of very great importance. It in a great number of cases bring the size of the apparatus within what can be allowed in private houses; and in consequence of the rapidity with which the retort can be worked, the gasometer may again be reduced to a still smaller size.

Another advantage gained by the small quantity of gas required for a flame, is the proportionate diminution of heat arising from the lights. The quantities of heat and light produced by the combustion of inflammable gases are by no means in the same constant relation to each other; one frequently increases, whilst the other diminishes; and this is eminently the case when coal gas and oil gas are burned against each other. The quantity of heat liberated is, speaking generally, as the quantity of gas consumed, and this is greatest with the coal gas; but the quantity of light is nearly as the quantity of carbon that is well burnt in the flame; and this is greatest in the oil gas.

The very compact state in which the apparatus necessary for the decomposition of oil can he placed, the slight degree of attention required, its certainty of action, its cleanliness, and the numerous applications which it admits of in the use of its furnace for other convenient or economical purposes, render it not only unobjectionable, but useful in manufactories and establishments; and these favourable circumstances are accompanied, not by any inferiority in the flame or increased expense, but by an improved state of the first, and saving in the latter.

Messrs. Taylor's have shewn great ingenuity in the construction of their whole apparatus, but the washer and gasometer deserve particular notice for their remarkable simplicity also. In the washer, two planes are fixed in a box or cistern, in a direction not quite horizontal, but inclined a little in opposite directions; the planes are traversed nearly across by slips of wood or metal, fixed in an inclined position on the under snrface, and which alternately touch one side of the cistern, leaving the other open and free. These planes being immersed

in water, the gas is thrown in under the lowest ridge, and by its ascending power is made to traverse backward and forward along the ridges fixed on the planes, until it escapes at the highest part of the uppermost ridge. Thus, with a pressure of 5 or 6 inches of water only, it is made to pass through a distance of 14 or 16 feet under tbe surface of the fluid, and become well washed.

The smaller gasometers are made of thin plate iron, and being placed in a frame of light iron work, look more like ornamental stoves than the bulky appendages to gas apparatus, which they supply. The larger ones are made very light, and when in pieces very portable, by being constructed of a frame of wood work, in the edges of which are deep narrow grooves; plates of iron fit into these grooves, which being caulked in and painted over, make a light and tight apparatus. These are easily put together in any place, and may therefore be introduced into a small apartment, or other confined space, where a gasometer already made up would not enter.

Art. XIV. *Some Account of Cadmium. From the Annales de Chimie, and Journal de Physique.*

Cadmium is a metal which was first discovered by M. Stromeyer in the autumn of last year, whilst examining the medical preparations in the shops of Hanover. Some impurities were found in the oxides of zinc, which on examination proved to be this new metal. In the month of April of this year, Mr. Hermann, of Schoenebeck, near Magdebourg, having occasion to examine some oxide of zinc he had prepared for sale, and which was said to contain arsenic, found it to contain the oxide of a new metal, and communicating his results to M. Stromeyer, they were soon identified with the previous but unpublished discovery of that philosopher.

This metal very much resembles tin in its colour, lustre,

degree of hardness, ductility, and in the peculiar sound it causes when bent. Its specific gravity is 8.635.

It fuses, and is volatilized at a temperature a little below that required for tin.

It preserves its lustre in the air at common temperatures, but when heated becomes changed into an oxide of an orange yellow colour, not volatile, and easily reducible.

This oxide does not colour borax; it readily dissolves in acids, and forms colourless salts, from which it is precipitated white by alkalies.

Sulphuretted hydrogen precipitates it of a bright yellow colour, and thus led to the supposition that it was arsenic.

Zinc precipitates it in the metallic state.

The ore of zinc which furnished the oxide in which M. Hermann discovered this metal, came from Silesia.

Art. XV. *On Sirium. By* M. Faraday, *Chemical Assistant in the Royal Institution.*

The discovery of a new metal called Sirium, was communicated some months ago in a letter from Vienna, and published in the Annales de Chimie, as follows.

"The metal Sirium is obtained from the ore of nickel of Schladminget, in which it is accompanied by much arsenic and nickel, and a little cobalt and iron. After the ore is fused with glass, it is pulverised and dissolved in nitric acid, the excess of acid is saturated, and acetate of lead added; arseniate of lead precipitates, but arsenic still remains in solution. The excess of lead is separated by sulphate of soda, the liquor is filtered, and a little acid added, which is indispensibly necessary to have the Sirium pure. After having passed a current of sulphuretted hydrogen gas through the solution, it is to be neutralized by carbonate of potash, until a precipitate is formed, which is not resoluble; then sulphuretted hydrogen is again to be passed through the solution, and the Sirium is precipitated, combined

with sulphur. An essential character of this metal is, not to be precipitated from its solutions by sulphuretted hydrogen when there is excess of acid; and to be precipitated by it when there is no excess."

"The green liquor from which the Sirium has been precipitated contains nickel, cobalt, and iron."

"The sulphuret of sirium being heated in a crucible lined with charcoal, a scorious black mass is obtained having a metallic fracture. It is to be powdered and heated for half an hour with one fifth its weight of oxide of arsenic, at 60° W. Mr. West, the discoverer, obtained in one experiment a spongy regulus, and in another a compact metallic mass, which was the Sirium, still containing sulphur, arsenic, nickel, and iron, because the filtre had not been well washed."

The Editor of the Annales de Chimie observes, that "such is the account communicated of this discovery, which has caused a strong sensation amongst the men of science in Austria. The writer of the letter has perhaps omitted the most important particulars; for no one would believe in the metal of Mr. West, but rather in his inexperience. As he appears ignorant that nickel is not precipitated from its solutions by sulphuretted hydrogen when they are acid, and that it is in part when they are neutral, we should wish him to ascertain whether his Sirium is not very impure nickel."

Sir Humphry Davy received some of this metal from Mr. West, of Gratz, and sent a few particles of it in a letter to Mr. Hatchett, expressing strong suspicions as to its being really a new metal. Mr. H. placed a globule weighing about $\frac{4}{10}$ of a grain in my hands for examination. It was brittle; its fracture irregular, but crystalline, and of a reddish grey colour, approaching towards bismuth.

The globule was placed in dilute nitric acid, and heated; it was acted on with moderate rapidity, liberating nitrous gas; a solution of a yellow tint, (partly occasioned by nitrous gas,) was obtained, and a black insoluble powder separated. When the globule was about half dissolved, the clear solution was decanted off and evaporated to dryness. It formed a yellowish green salt, which, on being redissolved, afforded a light green solution. This solution tested on a glass plate by nitrate

of barytes, threw down sulphate of barytes. Ammonia being added in excess to the remainder, threw down oxide of iron, which being filtered off, left a clear blue solution. The iron was redissolved in muriatic acid, and thrown down by prussiate of potash; the ammoniacal solution was tested by prussiate of potash against a comparative prepared solution containing nickel, nitric acid, and ammonia, and precipitated white like it; and the remainder being evaporated to dryness, and heated to drive off the nitrate of ammonia, &c. and the oxide redissolved in muriatic acid, a green solution was obtained, which was thrown down white by prussiate of potash.

Sulphur, iron, and nickel, are therefore rendered evident by these experiments.

The remainder of the globule with the black powder were acted on by nitro-muriatic acid, and soon dissolved. A bright yellowish green solution was obtained, which gave a green salt on evaporation. This redissolved in water left a heavy white flocculent powder, and the solution, which was green, precipitated nitrate of barytes, became blue by ammonia, afforded iron, and a solution with acid which precipitated white with prussiate of potash, as before.

The insoluble substance I took to be oxide of bismuth, or a metallic arseniate. Heated with dilute nitric acid it dissolved, and was not precipitated by water. Into a part of the acid solution nitrate of silver was dropped, and then ammonia carefully added until the whole was neutral; a yellow precipitate fell, resembling exactly the arsenite of silver. To the remainder was added potash in excess, which was heated with it. Iron fell down and was separated; and then sulphate of copper being carefully added to the solution, a greenish precipitate was produced.

On making comparative experiments, it required between two and three drops of a saturated solution of white arsenic in potash, specific gravity 1051, with about twenty of a weak alkaline solution, the bulk and other circumstances of the solution obtained from the globule being imitated, to produce the same tint of green on the addition of sulphate of copper. The two drops gave a precipitate more blue; the three drops, one more green.

In consequence of the minute quantity of the metal which I possessed, I could not make any other experiments. It is evi-

dent that it has no claim to the character of a peculiar metal, but is a very impure mixed regulus. It contains sulphur, iron, nickel, and arsenic; and these make up very nearly, if not quite, its whole mass. I should guess the iron to be nearly equal to one third of the whole weight.

Dr. W. H. Wollaston has, through Mr. Hatchett, kindly permitted me to state, that having received from Mr. Hatchett the remainder of the very small quantity sent to him by Sir H. Davy, he subjected it to examination, and ascertained it to be a sulphuret, the principal metal being nickel, with small portions of iron, cobalt, and arsenic.

Art. XVI. *Some Observations on the Temperature of the Boa Constrictor. By Mr.* Wilford.

It is perhaps not generally known that the Boa Constrictor of Linnæus, changes its temperature as that of the atmosphere becomes altered; but that such is the case, appears from the annexed table. During my residence in Africa, I purchased one of these animals from a Mandingo man; these people occasionally bringing them to Sierra Leone for sale, under the name of tame snakes.* It was 3 feet 4 inches long, and grew one inch in a year and a quarter. It lived on rice flour, and this was the only article of food I ever observed it to eat; it drank about a table spoonful of water every other day, and evacuated the intestines seldom more than once a week; the urine was voided once in 8 or 10 days, in quantity about an ounce. Occasionally washing in water seemed to prove highly refreshing and beneficial. Approaching the north, on my return to England, the snake became more and more torpid, and at length died; the power of generating heat being too feeble to support the diminution of atmospheric temperature.

In the month of April 1816, this animal cast its skin, and

* Those animals are not poisonous, and their power consists merely in muscular force. In their habits they are mild and docile, and possess very little of that ferocity and subtleness which characterize the species. Mr. Wilford's snake was his companion, sometimes even at table, for a long period of time.

for three weeks previous to the time neither eat nor drank. As soon as the old skin was completely thrown off, it resumed its wonted activity.

1815.	Day of Month	Hour of Day.	Temp. of Atmosp.	Temp. of Snake.	Observations.
October	28	8 a.m.	$79\frac{1}{4}$	$79\frac{1}{4}$	
		$3\frac{1}{2}$ p.m.	$82\frac{1}{4}$	$82\frac{1}{4}$	
	29	8 a.m.	78	81—	The snake had been handled previous to this observation, which made me suppose the temperature might be increased, but an hour after, it was the same.
		9 a.m.	$78\frac{3}{4}$	81	
		$4\frac{1}{2}$ p.m.	$83\frac{1}{4}$	82	
	30	8 a.m.	78	80	
	31	9 a.m.	$77\frac{1}{4}$	$77\frac{1}{4}$	
Nov.	1	9 a.m.	$78\frac{3}{4}$	78	
	2	9 a.m.	77	$77\frac{1}{2}$	
	3	9 a.m.	$78\frac{3}{4}$	$79\frac{1}{2}$	
	4	9 a.m.	$77\frac{1}{4}$	78	
		4 p.m.	83	$81\frac{1}{2}$	
	5	9 a.m.	$79\frac{1}{4}$	$79\frac{1}{2}$	
	7	9 a.m.	$78\frac{1}{4}$	$78\frac{1}{2}$	
	8	4 p.m.	$82\frac{1}{2}$	$81\frac{1}{2}$	
	9	9 a.m.	78	78	
	10	9 a.m.	$78\frac{1}{4}$	78	
	11	9 a.m.	$80\frac{1}{4}$	79	
	12	9 a.m.	$79\frac{1}{4}$	78	
	14	8 a.m.	$78\frac{1}{2}$	$78\frac{1}{2}$	
	17	8 a.m.	80	80	
	20	$7\frac{1}{2}$ a.m.	76	77	
	21	8 a.m.	76	$76\frac{3}{4}$	
	22	$8\frac{1}{2}$ a.m.	78	78	
	26	8 a.m.	80	79	
	27	9 a.m.	78	78	
	28	9 a.m	77	78	
		11 a.m.	73	76	
	29	9 a.m.	74	76	
Dec.	8	9 a.m.	77	78	
	11	8 a.m.	77	78	
1816. Jan.	2	8 a.m.	75	75—	Pulsation of the heart 23 in a min
	19	6 a.m.	72	75	
	23	$7\frac{1}{2}$ a.m.	76	78—	Pulsation 25.
February	13	9 a.m.	80	$81\frac{1}{2}$—	Pulsation 24.
	24	7 a.m.	78	$79\frac{1}{2}$	
April	11	7 a.m.	79	80	
May	23	9 a.m.	80	80—	Pulsation 15, soon after 20.
June	5	6 a.m.	$74\frac{1}{4}$	75	

Art. XVII. *An Inquiry into the Connection between Crystalline Form and Chemical Composition, and the Causes which influence the Changes of the former in the same Mineral. By* F. S. Beudant. *Presented to the Royal Academy of Sciences,* 17*th February* 1817, *and* 30*th March* 1818.

The two papers in which M. Beudant gives an account of his ingenious experiments, are replete with interest and information; we therefore propose to give a condensed abstract of them; and as they lead to conclusions at once novel and important, we shall, with great deference, hazard a few remarks in conclusion.

It has long been matter of dispute with chemists and mineralogists, what ought to be the basis of mineralogical arrangement. The opponents of a classification purely chemical, object with truth, that, although *in theory,* composition is the source of all the characters which minerals present to us, yet *in fact,* owing to the imperfection of our knowledge in this branch of science, chemical analyses present us with so many discordant results, as to give us great reason to doubt whether the labours of even our best chemists furnish us with the real constituent elements of the minerals which they have examined. On the other hand, with respect to crystallographical character, it is now generally admitted that, although the same compound constantly gives the same crystals, yet that the inverse of the proposition is also true *only in theory*; the same elements being often found connected with incompatible crystallization, and dissimilar elements being discovered in uniformly crystallized bodies. It was to determine the proportion of extraneous matter capable of entering into the composition of a body, without affecting its crystalline form, that the experiments of our author were undertaken, and the following results obtained.

Those salts which mix best with each other in crystals, are those which are composed of the same acid; next, those with

the same base; and, lastly, those which have no connection either by their acid or base, mingle together but in very small quantities.

Mixtures of sulphate of iron and sulphate of zinc constantly furnished crystals with the rhomboidal form of sulphate of iron, provided they contained as a *minimum* 0.15 of the former salt.

Mixtures of sulphate of iron and sulphate of copper gave the same results with 0.09 of the former.

And, lastly, from mixtures of sulphate of iron with both sulphate of copper and sulphate of zinc (in the proportion of about three parts of the first to one of the second), M. Beudant obtained crystals with the form of sulphate of iron, which contained only 0.03 of that salt.

Thus it appears that sulphate of iron may, without affecting the crystalline system which characterises it, be *mixed* with $5\frac{2}{3}$ parts of sulphate of zinc, or 10 parts of sulphate of copper; or lastly, with 32 parts of sulphate of zinc and sulphate of copper combined. The general conclusions of this first Memoir may therefore be reduced to these three.

1st. The *mixtures*, which we have every reason to believe, both from the discordant results of their analyses and from other circumstances, exist in a great number of minerals, and above all in the class of stones, may be therein contained in much greater proportion than the essential and definite compound.

2d. Chemistry not having yet found means to distinguish these mixed ingredients from the constituent principles, their bodies may for the present be arranged in double classes, placing them under the species which gives the form, and if the proportions of that and the other ingredients be equal in giving them that place alone, but where any of the other ingredients predominate, placing them also under class of the predominating body.

3d. Until chemists shall have brought the art of analysis to greater perfection, nothing is left to the mineralogist to guide him in the determination of mineral species, but the observa-

tion of the crystalline system, which has always hitherto been found to correspond with the analysis of such bodies as can be compounded and decomposed at pleasure.

M. Beudant next proposed to himself, to resolve the following question: What are the causes which enable the same mineral compound to assume a variety of crystalline forms, and in any particular case? What is it that determines a body to one particular form rather than to another, amongst the variety which it is capable of assuming?

These causes may be arranged under the four following heads:

1st. General circumstances of a variable nature, which must always be present at every operation of crystallization.

2dly. The influence of *mechanical mixtures* in the solutions from whence they subside upon crystalline forms.

3dly. The influence of *chemical mixtures* upon the same.

4thly. The influence of variations in the relative proportions of the constituent principles.

From experiments directed with great care to these several points, the following important results were obtained:

1st. The state of the atmosphere, the greater or less quickness of evaporation, the form of the vessels, their nature, the mass of the solution, its state of concentration, seem to exert no manner of influence upon the form which the salts employed are capable of assuming.

2dly. In a damp atmosphere salts, in dilute solution, have a great tendency to climb up the sides of the vessels, where they form a kind of crystalline vegetation.

3dly. Very dilute solutions, out of the contact of the air, where it is impossible for evaporation to take place, may deposit crystals in a greater or less space of time; but it seems that this effect more particularly takes place with the least soluble salts.

4thly. The nature of the vessels, by exercising different attractions upon the salts, determine the crystals to form themselves more or less quickly, and to groupe themselves variously in different parts of the solution; if they be covered with a

coat of grease, the crystallization takes place entirely upon the surface of the liquid.

5thly. The position in which the crystals deposit themselves in the midst of the liquid, has no other influence than in producing a greater or less extension of the crystal in one direction or another; the parts which bound it remaining constantly the same in number and position.

6thly. Temperature and electrical state seem to have no influence whatever upon the form of crystals; only at high temperatures crystallization is irregular, and the resulting masses of salt are very fragile.

7thly. Matters in nearly permanent suspension in a saline solution, have no power to vary the crystallization. These matters often dispose themselves in concentric layers in the crystal.

8thly. The crystallization of a salt, can only take place in the midst of an accumulation of foreign matters in a state of fine division, as long as it is covered by a portion of the solution. The crystals which form in this state, always carry along with them some portion of the mixture, which is disposed more or less uniformly in their mass, but never in concentric layers. When the solution is dilute, the crystals are always of a more simple regular shape than when they are allowed to form freely. When concentrated, crystals are formed, the faces of which are hollowed out more or less in pyramidal excavations.

9thly. Other crystallization of a salt may take place in a medium of gelatinous consistence, without its being necessary that any of the liquid should swim upon it; in such circumstances the crystals include no portion of the foreign matters, and undergo no change of form; but they are almost always isolated, and extremely regular and neatly defined in all their parts.

10thly. When several salts are found in solution in the same liquid, it would seem that without being susceptible of chemical action or mixture, they are capable of mutual influence upon each other's crystallization. Thus, for example, muriate of soda assumes the cubo-octohedral form when it is made to

crystallize in a solution of borax, or better still of boracic acid.

11thly. The forms which a salt is capable of assuming, vary with the nature of the liquid in which they combine. Thus alum crystallizes in cubo-octohedrons from the nitric acid, and in cubo-icosahedrons from the muriatic acid.

12thly. Whenever several salts are susceptible of *chemical mixture*, that is to say, when they can unite without entering into definite combinations, the salt, whose system of crystallization prevails, always crystallizes in particular forms different from what it would have assumed if in a state of purity.

13thly. Chemical action, which by altering the composition of a salt, induces a particular form, produces effects differing according to its energy, and often gives rise to many varieties of crystals at the same time: thus, the action of an insoluble carbonate upon alum, occasions in the same solution octohedral, cubo-octohedral, and cubic crystals; and an uncrystallizable matter remains which contains less acid than any of the other salts.

14thly. When simple crystals of different forms, but of the same salt, are redissolved together, two things may happen. If the crystallization takes place slowly, the crystals deposit themselves separately one after another; but if rapidly, one compound form only is the result, which partakes at the same time of both simple forms. Thus it is that octohedral and cubic crystals of alum may unite and give rise to cubo-octohedral crystals.

15thly. Crystals of a compound form may frequently be decomposed into several simple forms by different gentle and successive solutions and crystallizations. Thus cubo-octododecahedral alum furnished separately octohedrons, cubes, and cubo-dodecahedrons.

Lastly, crystals of one form being placed in a solution of the same substance, which naturally would furnish crystals of another form, augment by additions of the new form.

Le Blanc was the first to notice this phenomenon, and M. Beudant has repeatedly verified the observation.

The following is a general recapitulation of the variations of form of several salts in determined circumstances.

1st. Sulphate of iron crystallizes constantly,

In simple rhomboids, by the chemical mixture of sulphate of zinc or sulphate of nickel;

In rhomboids truncated at the summit, by the mixture of sulphate of zinc or sulphate of magnesia;

In rhomboids truncated on the solid lateral angles, by the mixture of sulphate of alumine;

In rhomboids truncated at once on all the solid angles, by the action of borate, and phosphate of soda, or in crystallizing from muriatic acid.

The addition of a few drops of sulphuric acid to the solution, gave rise to additional facets which the salt did not assume before. The subtraction, on the contrary, of a portion of acid by any means, destroys the tendency which a salt may naturally have to various additional facets. Mechanical mixture also of foreign matter gives rise to greater simplicity in the crystals.

2d. Sulphate of copper, submitted to different trials, presented,

The primitive *form truncated upon the lateral obtuse edges,* when formed in water mixed with sulphuric acid;

The primitive form truncated upon all the lateral edges, by the mixture of sulphate of nickel or sulphate of alumine; lastly, many various forms which have not yet been described, from the effect of the mixture of the sulphates of soda, potash, ammonia, tin, mercury, or from the effect of a portion of its own acid, &c.

3d. Alum afforded

The complete octohedron, when pure and brought to a perfectly fixed state of combination;

The cube, when deprived of a portion of its acid;

The cubo-octohedron, by crystallization in nitric acid, was the consequence of a rapid crystallization of a solution, which contained at the same time both cubic and octohedral alum;

The cubo-icosahedron, by crystallization in muriatic acid;

The cubo-octo-dodecahedron, by the mixture of a small quantity of borate of soda.

4th. Muriate of soda crystallized

In cubes, in pure water;

In octohedrons, by the chemical mixture of a sufficient quantity of urea;

In cubo-octohedrons, by the mixture of a smaller quantity of urea, or by the action of borate of soda, or still better of boracic acid.

5th. Muriate of ammonia crystallized

In octohedrons, in pure water;

In cubes, by the mixture of a certain quantity of urea;

In cubo-octohedrons, by the influence of a salt of copper in the solution.

6th. Acid sulphate of potash crystallized

In a kind of irregular tetrahedron, in concentrated sulphuric acid;

In perfect rhomboids, in sulphuric acid, diluted with its own bulk of water;

In rhomboids truncated at the summits, in sulphuric acid, diluted with double its own bulk of water;

In crystals more or less complex, in proportion as the acid becomes less abundant in the solution.

7th. Double sulphate of potash and magnesia assumes the form of

An oblique prism with a rhombic-base, when the sulphate of magnesia is in excess in the solution;

The same prism truncated upon the two solid obtuse angles, when formed in water mixed with sulphuric acid;

The same prism modified upon the solid acute angles, when the sulphate of potash is in excess.

8th. Double sulphate of potash and copper crystallizes *in an oblique prism with rhombic base,* when the sulphate of copper is prevalent, and in forms more or less complicated, in proportion as the two component salts vary in quantity, or as the acid is more or less abundant, &c.

The direct end of these experiments being the explanation of

all those variations of crystalline form which each mineral substance presents, M. Beudant thus proceeds to discuss the application of their results, according to the indications which are furnished by nature.

I am far, says he, from pretending that nature, to vary the crystallization of those bodies which are found in her recesses, has solely restricted herself to causes analogous to those which these experiments have pointed out to me; but in comparing natural facts with those which I have observed in the course of my inquiry, it seems to me, that there is sufficient analogy to induce us to conclude that the causes which I have assigned, are, at any rate, amongst the number of those which have determined the variety of crystallization with which we are presented.

Thus the effects of mechanical mixture upon the crystallization of minerals, is absolutely identical with these above described, that is to say, they prevent the formation of additional facets. Axinite is the substance which presents us with this effect in the most striking degree. It is well known that the same specimen sometimes furnishes us on one side with crystals mixed with chlorite in oblique parallelopepidons perfectly complete; while on the other, there are crystals mechanically pure, which are modified by additional facets more or less in number. The quartziferous carbonate of lime from Fontainbleau, has never yet been found but under the form of rhomboids, perfectly simple in all their parts. Ferruginous quartz, which is the result of a mixture of oxide of iron, never affords those additional facets which sometimes modify the crystals of pure quartz, and very rarely those other irregularities which are so common in the latter. Natural crystals also, which are formed in the midst of a paste of foreign matters, also furnish accidental characters analogous to those which have been detected in artificial crystals. If the paste be coarse and formed of slightly cohering particles, the crystals are composed of detached concentric layers, and their faces are often more or less pyramidically hollowed out; such for instance are the crystals of quartz, which are found at Chamouni in a col-

lection of incoherent earthy matters. If the paste be composed of very fine particles, the crystals which are formed in the midst of it are well defined in all their parts, and perfectly isolated. Such are the crystals of boracite, of carbonate of iron, &c. which are found in the midst of gypseous depositions.

The modifying action resulting from different bodies dissolved in the same liquid, must have been of very frequent occurrence in nature, since mineral substances are very seldom found crystallized alone. Thus magnetic oxide of iron (fer oxidulé) occurs at Travusille in Piémont in three different rocks very near to one another, in serpentine, pyroxene, and yellow steatite. In the first, it is found in complete octohedrons; in the second, in octohedrons passing into cubes by the truncation of the solid angles; and in the yellow steatite, where they are moreover accompanied by calcareous matter, they occur only in rhomboidal dodecahedrons.

The action of chemical mixtures would also seem to produce on mineral substances effects analogous to those upon artificial salts; for, carbonate of lime, mixed in various proportions with iron and manganese, tends always to the primitive rhomboid; carbonate of lime, mixed in various proportions with carbonate of magnesia, also generally assumes the primitive rhomboid; and it is under this form, that it is always found imbeded in the calcareous rocks of the Alps.

It is difficult in the actual state of science, to appreciate the effects which chemical mixture has upon the crystallization of mineral substances. This difficulty depends upon three principal causes. The first is, that for analysis, the purest parts of the substance have with reason been selected; a second, that we do not yet know the definite composition of a sufficient number of mineral species, and therefore it is impossible to determine what are the matters mixed; and, lastly, chemists in their analyses have not rigorously described the varieties of crystallization which they have examined. Nevertheless, if we consider that the different analysis of the same substance often present us with very different results, and that in nature, the different mineral species very rarely crystallize alone, we

shall be led to believe that a determined species may often be found chemically mixed with such and such others. Moreover from the experiments recorded above, it is probable that these foreign ingredients exercise a modifying action upon the crystallization of the one whose form prevails.

As to the modifications occasioned by variations in the relative proportions of the constituent ingredients of bodies, we must necessarily have recourse to particular experiments to ascertain their occurence in nature. And here it is remarkable, that in the various analysis of the same acidiferous substance, made or repeated by the most experienced chemists, there often exist slight differences in the proportions of the acid and its base. And as in the experiments of M. Beudant, these differences, although confined to very narrow limits, give rise to particular crystalline forms, he thinks that there is reason to suspect that the analyses to which he refers, have been made upon different crystals of the same substance.

He further thinks, from the observations of Le Blanc, who proved that an octohedral crystal of alum, placed in a solution of cubic alum, passes by the superposition of matter into a cube, that the additions which we may often observe upon natural crystals, arise from the circumstance of a crystal of a certain form being placed by some accident in a solution affording crystals of another form.

Lastly, those specimens which present different crystals of the same substance, whose relative positions point out different epochs of formation, furnish, in his opinion, another argument in favour of variations occasioned by differences of proportion of constituent principles; for these successive depositions present a striking analogy with the successive depositions of octohedrons, cubo-octohedrons, cubes, and cubo-dodecahedrons, which he obtained from the same solution of alum, wherein the elements of that substance he supposes were in very indeterminate proportions. The solution from whence such natural crystals were deposited, he thinks it probable, did not originally contain definite proportions of the elements of the substances with which they are connected, and that the consequence of the slow

crystallization which appears to have taken place in nature, has been, that these elements have divided themselves into different combinations, which have given rise to the different varieties of crystallizations upon the specimen.

Having thus endeavoured to give a brief account of the principal results of M. Beudant's experiments, and of the conclusions which he derives from them, we most heartily recommend all those who are interested in the subject, to the study of the details in the original; whilst we entreat our ingenious Author's pardon for a few observations which have occurred to us in the perusal of them.

Dr. Wollaston, in some observations on M. Beudant's first Memoir,* has objected, that he is not correct in considering all the salts which he obtained in his first experiments as *mixed crystals*, owing their form to sulphate of iron alone, for that some more intimate chemical union may be presumed to occur, in those instances at least in which a transparent crystal is obtained. It is obvious that no *mixture* of bodies which differ so much in refractive power as the sulphates of iron and copper, can suffer light to pass directly through the mass with the transparency which is observable in some of these salts.

To this M. Beudant has replied,† that he never considered these crystals as *mechanically mixed*, but that he has all along distinguished the compounds as *chemically mixed*; and he thinks that he has got rid of the objection by this distinction.

Now it does appear to us, we must own, that this is mere confusion of terms, in which the true question is allowed to escape, and the difficulty remains in our minds just as stated by Dr. Wollaston. The difference lies between mixture and combination, or, in other words, between mechanical union and chemical union. Two bodies may be mechanically united, or they may be chemically united; chemically speaking, they may be mixed, or they may be combined. But according to the usual acceptation of the terms, two bodies cannot be

* Annals of Philosophy, for April 1818.

† Annales de Chimie, &c. April 1818.

chemically mixed or *mechanically* combined. A chemico-mechanical, or a mechanico-chemical union, we must confess, we do not understand.

May we be excused for saying, that the distinction thus drawn by M. Beudant, has very much the character of an after thought, when we remark that the original question which he proposed to resolve was, we believe, in his own words, to "déterminer jusqu'à quel point un *composé chimique défini* peut admettre de *principes étrangers, présumés à l'état de mélange* sans que le système cristallin qui lui est propre soit changé?"

On another point Dr. Wollaston and M. Beudant are at issue; the former adduces another compound having, to all appearance, the same form as sulphate of iron, although entirely free from that salt.

"If equal quantities of sulphate of copper and sulphate of zinc (*both perfectly free from iron*) be dissolved together and suffered to crystallize, the first crystals formed are those of sulphate of copper (but of course impure). The after crystals are of a paler blue colour, and consist of the two sulphates of copper and zinc combined, presenting to all appearance the form of the same rhombic prism before observed, with the same obliquity of its terminal face."

M. Beudant replies, "les expériences analogues que j'ai faites, m'ont prouvé que ces cristaux semblables à ceux du sulphate de fer, renferment tous des traces de ce dernier sel; et je suis porté à croire que ceux que le savant chimiste a obtenus en renferment également."

M. Beudant must again excuse us, if we at least suspend our judgment. He will the more readily allow us this privilege, when he calls to mind the following introduction to his answer. "L'écrit de M. Wollaston, je regrette infiniment me parvienne précisement la veille de mon départ pour un long voyage, et cette circonstance m'a obligé d'écrire à la hâte."

Has M. Beudant repeated the experiment since at more leisure? The quantity of sulphate of iron which, according to his own principle, would be necessary to impress its form upon the compound, is not so mere a trace as to render it likely to

have escaped the observation of even a bungler in chemistry when expressly looking for it. Dr. Wollaston has declared that the salts he employed were " both perfectly free from iron."

In his second Memoir, we think that M. Beudant has admirably traced the influence which avowedly mechanical mixtures in the solution have upon crystallization, and the analogy which exists between the products of art and those of the mineral kingdom. The influence also, of what he terms *chemical mixtures*, both in the solution and in the crystals themselves (although one object to the term as indicative of a particular class of phenomena), is well followed and laboriously exposed; but doubts occur to us upon several points, as it is natural there should in a subject which is yet in its infancy.

There appears to be a great want of precision in the ideas of M. Beudant respecting the variations of form, occasioned, as he supposes, by difference of proportion between an acid and its base. To this class he refers the change of octohedral alum to cubes, and of cubic muriate of soda to octohedrons. But this change, it appears from his experiments, is permanent; that is to say, when once effected, the respective forms of crystals afford the same shapes when dissolved and recrystallized. Thus cubic alum will never by solution and evaporation, give octohedral crystals, nor octohedral muriate of soda, cubic crystals. But if this be the case, they can no longer be arranged as crystals of the same salt. Nor, indeed, according to our ideas, is alum deprived of a portion of its acid, any longer alum: it is a distinct and separate compound. It is much to be desired that M. Beudant had furnished us with an analysis both of cubic alum and octohedral muriate of soda; as, supposing this view of the subject correct, we should be very curious to know what were the definite proportion of acid in such, and in what degree they differed from the original salts. We say definite proportion, because we have no doubt but that it must be definite and fixed; notwithstanding, if we mistake not, we perceive a tendency to the contrary opinion, though not very clearly announced, in both the Memoirs before us. The subject, indeed, becomes still more complicated, when we are given to understand that, with respect to alum, there is another shape, namely, the dodecahedron,

which is no less permanent than the other two; so much so, that from a specimen of alum of commerce, which presented faces of the octohedron, cube, and dodecahedron, the three forms were obtained in succession by solution and careful evaporation. The cubo-octohedron of the same substance, in like manner was resolved into cubes and octohedrons; and this is the more remarkable, in as much as the two forms were intimately combined, and penetrated one another, and the compound crystal was not, as in Le Blanc's experiment, the result of one simple form increasing the other.

Another difficulty occurs to us. One of the distinctive characters of muriate of soda is, that its crystals break into cubic fragments; and this is true both of the cubic and octohedral varieties, so that the characteristic description of the crystallization of this salt, is not so much that it crystallizes in cubes, octohedrons, &c. as that its internal arrangement is such, that it is divisible in a direction parallel to the faces of a cube. Are we to understand, that all at once, the accidental distinction of external shape becomes as fixed and constant as the essential internal arrangement? Or, following the analogy to earthy mineral bodies, must we suppose, that cubic fluor spar differs from the octohedral fluor by some excess of base or acid, when both varieties are equally divisible in a direction parallel to the faces of an octohedron? and can we imagine that if it were possible to dissolve the two, they would both infallibly, together with their common interior structure, resume their original external shape?

We are aware that this changeability of form and permanence of structure present many curious problems, and that it is irreconcileable with the laws of attraction upon the Haüyan hypothesis; but in our opinion, it is perfectly reconcileable with the doctrince of spherical atoms; a doctrine to which, we cannot but express our surprise that, the French philosophers have never yet directed their attention. The subject is replete with interest, and there are many amongst them who are fully competent to do it justice.

Lastly, we cannot allow that the objection, though foreseen, has been obviated with respect to the mixture of iron,

manganese, and magnesia, with carbonate of lime, and the consequent tendency impressed upon this latter to crystallize in the simple primitive rhomboid. It is asserted, that carbonate of lime mixed with iron, and manganese, or with carbonate of magnesia, crystallizes generally in primitive rhomboids. It is well known that Dr. Wollaston, with his usual accuracy of observation, found a considerable difference in the measure of the angles of these salts; thereby distinguishing them as separate species. Therefore, the full answer to this illustration is, that they do not crystallize in the primitive rhomboid; and admitting the double carbonate of lime and magnesia as a species, the proposition is so far from being established, that we conceive that it tends to the very contrary conclusion; namely, that the addition of a second base to the same acid induces a peculiar distinctive form of crystallization, a result which we cannot help anticipating from the more rigorous admeasurement of some of the *chemical mixtures* of these Memoirs.

Once more we throw ourselves upon Mr. Beudant's candour to excuse the freedom of these remarks. Our mutual object is the same—the elucidation of truth; and it will give us great pleasure if in the pursuit of those labours which reflect so much honour upon him, he should have leisure for the consideration and removal of the doubts which we have ventured to express.

Art. XVIII. *Miscellanea.*

I. Mechanical Science.

§ 1. Mathematics, &c.

1. *Mathematical Problem.*

To the Editor of the Journal of Science and the Arts.

Sir,

I take the liberty of calling the attention of your mathematical readers to a difference in the solutions of a problem of the

utmost importance in mechanics, which is, that of a body revolving about in different axes in free space.

It appears from the proof of this problem given by Mr. Knight, of Papcastle, in the second volume of the Mathematical Repository, that if v, v', v'' &c. represent the velocities of a body about the respective axes of rotation, the instantaneous axis of rotation arising from the composition of them, will be $\sqrt{v^2 + v'^2 + v''^2 + \&c.}$ This is different to the result which may be deduced from the proofs of Lagrange and Laplace respecting the same subject, as I find them given in the notes to an English translation of the Analytical Mechanics of Laplace, lately published. I have since learned that Dr. Olinthus Gregory, in the third edition of his Mechanics, page 301, gives Mr. Knight's solution as the true one.

As men of such eminence disagree respecting this most abstruse and important problem, I frankly confess my inability at present to give a decided opinion respecting it; but shall feel highly gratified if this notice should prove the means of this difficulty being thoroughly investigated.

I remain, Sir, your's &c.

JAMES MARTIN.

2. *Mathematical Talent.*

A singular instance of early mathematical talent has been made known by Mr. Gough, in the Philosophical Magazine. Thomas Gasking, the son of a journeyman shoemaker of Penryth, is but nine years of age, he has, however, in consequence of the education given him by his father, an acute and industrious man, become well acquainted with the leading propositions of Euclid, reads and works algebra with facility, understands and uses logarithms, and has entered upon the study of fluxions. On being examined, he demonstrated propositions from the first books of Euclid; discovered the unknown side of a triangle from the two sides, and the angle given; and solved cases in spherical trigonometry. In algebra, he gave the solutions of a number of quadratic equations; answered questions which contained two unknown quantities; and ap-

plied algebra to geometry. He answered problems relating to the maxima of numbers and of geometrical magnitudes, with ease; and on many other mathematical points, gave promises of very high future excellence.

3. *Hydrometer.*

The Hydrometer is an instrument which may be made very useful in taking the specific gravity of solid bodies, and was applied for this purpose, I believe, by the late Mr. Nicolson. A modification of the usual form may be suggested, by which the specific gravity of the solid taken, may always be compared to pure distilled water, though the experiment be made in spring, sea, or any other water. For this purpose it would require that the degrees marked on the scale could be diminished or increased in bulk at pleasure, so that the same weight should sink the instrument an equal number of degrees in waters of different densities. This is easily done by a compound stem, having one part moveable on the other. The moveable part should be a wedge, or some form which has its bulk increasing in an arithmetical ratio; and this being attached to the fixed part of the stem of the instrument, on which the scale is supposed to be marked, so that the part of the instrument which is traversed by the surface of the water be between the extremes of this piece, it is evident that the bulk of the degrees may, to a certain extent, be changed at pleasure: and so as to correspond with the density of the water used. By noticing the descent of the instrument in the water, when the stem is in a certain state, it would be easy to form a short scale, which could be laid down on one side of the instrument, marking the relative position of the moveable part of the stem required.

The wedge might be placed on the stem, with either the apex or base downwards; or the compound stem might be formed of two wedges moving on each other, so that the sides should constantly be parallel. An advantage attending that construction, where the base of the added wedge is upwards, is, that the degrees would be most delicate for small weights; for their lengths would vary from the lower to the upper part

of the stem, in consequence of the angular form of the whole, and they could be most accurately read off from the lower and necessary part. M. F.

4. *New Theory of Colours.*

A new and very ingenious hypothesis of the cause of colours in bodies, has been proposed by M. B. Prevost, in which the effect is accounted for by radiation instead of by reflection. It has been generally imagined, that the different rays of light which fall upon bodies have been all absorbed except a certain number, which being reflected, produce an effect of colour, according to their nature. But M. Prevost supposes that coloured bodies reflect a portion of the light unchanged; whilst they act upon another portion which enters their substance and decompose it; one part is absorbed whilst the other is thrown off by radiation, and this last causes the colour of the body. The colour of bodies, as commonly observed, is altered by the white light mixed with the rays producing colour, but the former may be removed by a series of reflections from surfaces of the same substance, and the relative intensity of the true colour augmented. Thus a ray of light reflected several times successively from polished surfaces of gold, is at last deprived of all undecomposed white light, and gives a deep red orange colour, supposed to be the real colour of gold. The colour of copper obtained in the same way is a scarlet; that of silver, a fine yellow; and that of tinned iron, a deep golden yellow, of the common hue. On this hypothesis, it is evident that a distinction must be made between the colours of bodies as they commonly appear, and their eal colours; and the real or ultimate colour will differ more from the apparent colour in proportion as the light which is reflected or even absorbed, varies in quantity with the light decomposed. This is the case with the metals named above; and M. Prevost concludes from his experiments, that there is no metal which is properly white or gray, but that they all of them have some decided brilliant colour.

§ 2. Navigation, Agriculture, The Arts, &c.

1. *Nautical Instrument.*

Mr. Hunter of Edinburgh has invented an instrument of great importance in navigation. From two altitudes of the sun, and the interval of time between the observations, he can determine within five minutes after the second observation, the latitude of the place, the hour from noon, and the variation of the compass. According to the common form of calculation for double altitudes, the latitude by account is supposed to be known, which in the use of this instrument is not necessary. Mr. J. Cross, of Glasgow Observatory, attests that he has tried it in several instances, and always found its results very near the truth. If a vessel were driven from her course by storms or currents; if the reckoning was altogether lost, and the mariner could not get a meridian observation; with this instrument, and a chronometer, he could in a few minutes after the second observation, ascertain his position on the ocean with accuracy.

2. *Sounding Instruments.*

From experiments made in the Thames, below London Bridge, on the comparative merits of Massey's Sounding Lead, and the instrument known by the name of Gould and Burt's Buoy and Knipper, it appears, that the first is far superior. It gave the accurate depth of the river, whether delivered from fixed points, or from boats going along or across the river; whilst the other gave in some cases twice the real depth; and in others, as when taken across the river by a boat, with a line of 13 or 15 fathoms, would not sink at all, in consequence of the influence which the current possessed over it.

3. *Preservation of wrecked Persons.*

Experiments have lately been made by Mr. Trengrouse, particularly at the Serpentine river, to facilitate the means of establishing a connection between two places across water, as from a ship in distress to the shore, or between two shores. Mr. Trengrouse's method is to fire a rocket, to which a small

line is attached, from a musket. In this way, after a few trials, a line was thrown across the river, by which a hawser was drawn over, and this being fastened on each side to trees, a seat called a chaise volante was suspended from it. This ran on rollers, and could with facility be drawn across with a person in it.

A cork jacket has also been contrived by the same Gentleman, so constructed, as not to interfere with the motion of the arms.

4. *Steam Boats.*

The application of Steam Engines to the propulsion of boats and marine vessels, is now becoming very general; not only in England and America, but in other parts of the world. Experiments have been made with a steam boat on the Danube, between Vienna and Nusdorf, and have succeeded. A fine vessel called the Garonne has been launched at Larmont near Bordeaux, and has answered every wish of the builders; and it is said steam boats exist even at Naples.

5. *New Light-houses.*

Extract of a Letter from the Agents to Lloyd's, at Riga, dated 11th (23d) June, 1818.

"We are authorised to inform you, that at the mouth of the Duna, at the Dam of Fort Connet, a Light-house has been erected, which will be lighted from the 15th of June. The first fire is stationed 105 English feet, and the second in the same direction, 25 English feet above the level of the sea; in consequence of which the first will be perceived at a distance of 16, and the latter at a distance of 7 Italian miles. The purport of these new lights is, 1st, That their appearance may serve navigators as a guide, regarding the distance at which they may approach for anchoring; 2dly, That the direction of these lights on entering the mouths of the Duna may be conducive to avoid the reef, which stretches out to the sea from Magnersholm, as also the sand banks surrounding that island.

Notice is given in the French papers of a new Light-house erected at Calais, which will be lighted for the first time on

the evening of Tuesday, December 1, 1818, and be constantly illuminated after that time, from sun set to sun rise.

The light is to be white, and in consequence of its revolving, periodical. Each revolution will last three minutes, and exhibit during that time two lights, separated from each other by an interval of nearly a minute. The lights will increase and diminish in intensity, but the greatest effect will continue nearly 30 seconds.

Another Light-house has been erected by the King of Sweden, on the island of Ostergarn.

It is situated on the highest point of the island, about a German mile to the east of that of Gothland. It is 61 feet 5 inches high, to the lanthorn; and this part is round, and painted white. The lanthorn is closed in, and the roof painted black. The elevation of the light is 78 feet above the level of the sea. It was lighted on the 1st of September, and will continue burning till the 15th of May; but in future years, it will be lighted from the 1st of August, to the 15th of May. Coal is used as the fuel.

6. *Agricultural Premiums.*

The Board of Agriculture have offered the following premiums for experiments with Salt:

To the person who shall make, and report to the Board, the most satisfactory experiments on the application of salt, for assisting in feeding and fattening the live stock of a farm; the Gold Medal, or fifty pounds.

Accounts verified by certificates, specifying the number and quality of the stock fed, with the quantity of salt consumed, to be produced on or before the 1st of March 1820.

To the person who shall make, and report to the Board, the most satisfactory experiments to ascertain the advantages or disadvantages which have attended the use of salt as a manure, either simple, or mixed with other substances; the Gold Medal, or fifty pounds.

Accounts verified by certificates, specifying the nature of the soil on which the experiments are made, with the quantity

of salt, and the time of its application, and the effect on the crop cultivated, to be produced on or before the 1st of March 1820.

7. *Earthen Pipes for Agriculture.*

Earthen pipes have recently been made and brought into use in Hertfordshire for draining lands. The pipes are formed by means of a press, and are then burnt. They are afterwards laid down with a small quantity of coarse sifted gravel, without either bush, straw, or stubble. They are very economical.

8. *Premium for Rail Road.*

The Highland Society of Scotland have announced the following premium:

A piece of plate of 50 guineas value, will be given for the best and most approved essay on the construction of rail roads, for the conveyance of commodities. In this essay, it will be essential to keep in view how far rail roads can be adopted for common use in a country: the means of laden carriages surmounting the elevations occurring in their course; and whether rail roads, or the wheels of carriages, may be so constructed as to be applicable to ordinary roads, as well as to rail roads, so that no inconvenience shall be experienced on leaving either to travel on the other. The essay to be accompanied with such models or drawings as shall be necessary to illustrate the statements it contains.

It is desirable that some account should be given of the rail roads in Britain, together with a brief history of their introduction. The premium not to be decided until the 10th November, 1819.

9. *Prize Questions in the Arts.*

The Society for the Encouragement of Industry in France, have proposed the following prizes for the year 1819:

For the application of the steam engine to the printing press, so that a greater number of impressions may be taken than in the ordinary way, and more advantages gained; a prize of 2000 francs. The memoirs to be accompanied with designs, and certificates of the machine having been used for three months together.

For the fabrication of a new kind of carpeting, cheaper by one half than the commonest carpet *sold at Paris; a prize of* 200 francs. The article to be made before May 1819.

For the invention of solid and brilliant green colours, superior to Scheele's green, and those now in use, and fit to be used in dying, oil painting, and paper staining; 2000 francs.

For the best process of mixing colours in oil and water for the use of artists; 500 francs.

For a process by which animal charcoal may be prepared from other substances than bones, and by different means to those used in the preparation of Prussian blue; also in such quantity as to be sold as cheap as that from bones; 2000 francs.

For the discovery of a substance, either natural or prepared, which will completely answer as a substitute for mulberry leaves, in the keeping of silk worms; 2000 francs.

10. *Crayon Pencils.*

The finest grained charcoal that can be procured is sawed into slips of the size and form required, and put into a pipkin of melted bees wax, where they are permitted to remain near a slow fire for half an hour or more, in proportion to the thickness of the charcoal: they are then taken out, and when perfectly cool, are fit for use. By adding a small quantity of rosin to the wax, they may be made considerably harder; and on the contrary, should they be required softer, a little butter or tallow will answer the purpose. The advantages these pencils possess are, that they can be made at the most trifling expense, and at any time; and that drawings made with them are as permanent as ink, and not liable to injury by being rubbed or remaining in the damp. The above process will harden both red and black chalk, and make them permanent also. Transactions of the Society of Arts, &c.

11. *Escape from Fire.*

Feather beds have lately been recommended as a means of escape from fire, when others fail or cannot be obtained. The plan suggested is, that a few strong men should hold one in their hands extended, and that the persons in danger should throw themselves on to it, endeavouring to leap outward as

far as possible, from the front or wall of the house on fire. The neighbours would furnish the beds; and that they may instantly be ready, an ingenious association of the word *feather-beds* is proposed with the cry of *fire*, usual at those times, *fire-feather-beds*. The humanity of the suggestion, its easy application, and the importance of its successful results, entitle it to universal diffusion.

It may also be suggested here, that one means of escaping when the lower part of a house is on fire, is through the roof. This in many cases could be very easily effected. Retiring to the upper chamber and shutting the door, to prevent a current of air, an aperture may be made in a few minutes through the lath and plaister of the ceiling, and the tiled or slated roof, by a poker, the back of a chair, or a tester rod; and a way of exit procured. There are few cases where a table or box would not elevate the person high enough; and still fewer, where the roof would resist the force, even of a woman.

12. *Paper String.*

The Chinese frequently form packthread from slips of paper twisted; and packets at times come to this country bound round with this sort of string. The toughness of their paper adapts it in a peculiar manner for this use, and makes it surpass any similar article that we could produce. Perhaps however, it may not be uninteresting to suggest, that the common whited brown paper cut into slips and twisted, makes a moderately strong twine, which would fulfil, in the absence of the regular means, many useful purposes.

13. *Furnace Grates.*

An improvement is mentioned in the construction of the grates of large fire places, as in glass houses, &c. which prevents their destruction being so rapid as is generally the case. It consists in making them hollow, and passing a constant stream of water through them.

14. *On Dry Flax Dressing.*

Sir,

The dry preparation of flax, as described in Nos. VIII and IX of the Journal of Science and the Arts, is of so much importance to the country at large, that perhaps you will give admission to the following remarks, which will, I trust, elicit some explanation from Professor Millington of the Royal Institution, or from Messrs. Hill and Bundy, the patentees of the machinery in question. There appears to me such a vast difference betwixt the statements given in your Journal, that there must be either some mistake, or some explanation is required to set the subject in its proper light. Mr. Millington states, that one pound of stem, or dry flax from the farm, was passed through the breaking machine in five minutes, and afterwards through the rubbing machine in eight minutes, but that it was thought necessary to pass the flax a second time through the rubbing machine, which occupied three minutes more, in all sixteen minutes; and that the produce was exactly four ounces of clean fibre, fit for the hackle, from one pound of stem, or dry flax from the farm, being one fourth. See Journal of Science and the Arts, No. IX, p. 32, 33. With regard to the quantity produced, Mr. Millington is asked, how many pounds of flax could be prepared in twelve hours, and by what number of hands, by the machine? Answer, Twenty pounds, by one man and two children.

Would that machine require the full power of a man, or could he work more machines than one?—Answer, He could work one breaking and two rubbing machines, with three children.

Then the three machines would require how many hands?—Answer, One man and three children.

They would do sixty pounds?—Answer, No, forty pounds; twenty pounds the breaking machine, and twenty the pair of rubbing machines—See Journal, as above, page 39. Mr. Millington says, that one man and three children can prepare *forty pounds;* but here there must certainly be some mistake, for his continuation states, *twenty pounds by the breaking, and*

twenty by the pair of rubbing machines. Now it is manifest, that the twenty pounds passed through the pair of rubbing machines are the identical twenty pounds that had previously passed through the breaking machine, it being a continuation of the same process on the same quantity of flax, to prepare it for the hackling machine. If I be correct in what I have stated, it would appear that only *twenty* pounds are *fully* prepared for the hackle by one man and three children; the expense of which, at only 1*s.* 10*d.* to the man, and sixpence to each of the children, would amount to two-pence for each pound of flax, or 18*s.* 4*d.* per cwt. and this besides the expense of hackling. Mr. Prentice, in the employ of Messrs. Hill and Bundy, states see Journal as above, page 42.) that one man could turn two breaking machines, two rubbing machines, and one hackling machine; and this would require five boys, *viz.* two to feed and attend each breaking machine, and one to attend the two rubbers and hackle; that each breaking machine would produce from 80 to 100 pounds of prepared flax in a day, and each rubbing machine would do half an hundred weight in the same time; so that two rubbers would be necessary to each breaker." How are we to reconcile these discordant statements?

I have, I think, made it clearly appear, that by Mr. Millington's evidence, only twenty pounds of flax can be completely prepared for the hackle by one breaker and two rubbers, although Mr. Millington, in his way of reckoning, says forty pounds. Mr. Millington, by weighing the lint and looking at his watch, seems to have adopted a very accurate mode of determining the quantity of work done, and we may presume that the result of labour for a short space of time, would be greater than if the work were continued for ten hours. If we take then the number of machines wrought by one man, and the necessary number of children, as stated by Mr. Prentice, and calculate the work done from the data furnished by Mr. Millington, we ought to approximate to the truth, and will have the following result. Two breaking machines, two rubbing machines, and one hackling machine are wrought, as

stated by Mr. Prentice, by one man and five children. The two breaking machines, at the rate of one pound passing through each in the five minutes, as stated by Mr. Millington, would pass twelve pounds of stem or rough flax, an hour, each machine ; or 240 pounds both machines in ten hours. As two rubbing machines are required for *each* breaking machine, it is evident that the two rubbing machines wrought along with the two breaking machines (as stated by Mr. Prentice) can only rub *one half* of the quantity produced by the latter. We have therefore 120 pounds of stem that have passed through both the breaking and rubbing machines; and 120 pounds that have passed through the breaking machine only. The former quantity is in a complete state of preparation for the hackling machine, and has been reduced by the breaking and rubbing to 30 pounds, one fourth of the original quantity. It may perhaps be rather difficult to calculate the result of work when the whole of the material is not in the same state of preparation; but if we suppose the *half* of the second portion of stem to be *fully* prepared for the hackle, instead of the *whole* to be *half* prepared, we cannot be far from the mark: this will give 30 pounds of flax from the first quantity of 120 pounds of stem, and 15 pounds for the second portion, on account of the latter having only passed the breaking machines—in all, 45 pounds of flax prepared for the hackle. This preparation costs the work of one man and five boys in a day, which, a 1*s*. 10*d*. for the man, and 6*d*. for each of the children (too low) makes four shillings and four pence for 45 pounds of flax, which, it is but fair to suppose, has been finished by hackling, as the hackling machine was moved along with the breakers and rubbers. We have then, finally, to pay 10*s*. 10*d*. for the preparation and hackling of 112 pounds of flax. I have reason to think that in my calculations I have committed no essential error, but will the data I have assumed be conceded? As it is agreed by all parties that two rubbers are required for each breaking machine, will Messrs. Hill and Bundy assert that *more* than one pound of stem can be passed through a breaking machine in five minutes? As I have already observed, it is likely that the quantity of work done

by the breaking machine in five minutes, as noted by Professor Millington, would be more than the proportion of work done if continued for ten hours. It would be very desirable that experiments on this point were repeated, and that it was exactly ascertained how much stem can be passed through a breaking machine in the hour.

If no more than twelve pounds of stem can be passed through each breaking machine in the hour, it appears evident to me that no more than 45lbs. of flax can be prepared and hackled in a day, by two breaking machines, two rubbing machines, and one hackling machine, wrought by one man and five children. Professor Millington's experiment is direct and exact; the quantity of stem being weighed, and the period of time noted by a watch. Let Messrs. Hill and Bundy institute experiments as exact, and the result will decide which statement is the most correct. Until this is done, we are bound to presume, with Professor Millington, that only one pound of stem passes through each breaking machine in five minutes; and upon this datum, and that two rubbers are required for every breaking machine, as allowed by all parties, we can calculate with tolerable precision, the quantity of work done, and the expense.

I have the honour to be, Sir,

Your most obedient humble servant,

G. J.

P. S. Should the above remarks be deemed worthy of a place in your Journal, and should they not reach in time for insertion in the Number for October, it might, perhaps, be proper to transmit them to Professor Millington, and to Messrs. Hill and Bundy, so that their observations on the statements they have made, and the calculations and inferences made by me, may appear at the same time. It will give me much pleasure to find that I am in the wrong; and that such a national benefit is likely to arise from the adoption of the machinery invented by Messrs. Hill and Bundy. When on this subject, I would wish to ask them, whether the present arrangement of two breakers, two rubbers, and a hackling machine, could not be occasionally altered by removing one of the breakers, and substituting a pair

of rubbers? As it now stands, the breakers perform twice the work that can be done by the rubbers; but it would be very convenient to equalize the produce from each. Two breakers and one pair of rubbers, for five hours, and one breaker and two pair of rubbers for other five hours, would finish the whole quantity for the hackle, which last, probably hackles what is prepared by all the other machines. The public is not informed what is the cost of these machines, the space they would occupy, their weight, or freight, &c. G. J.

15. *Professor Millington's Reply.*

In reply to the above letter, which was put into my hands before it went to press, I beg to say, that I feel pleasure at all times in giving every explanation and information in my power; and although there does appear to be some inaccuracies in the account alluded to, yet, upon reference to the notes I made at the time, they are much less than may at first be expected, and chiefly arise from the short-hand writer having made some omissions, (a circumstance which is by no means uncommon, particularly in subjects which he is unacquainted with) in parts of the questions and answers. But in giving the Report of the House of Commons on any subject, it must of course be given as that House prints it, for it would be presumption in any one to attempt to alter it, though its ambiguity might have been explained by notes. In the first place, by the experiment which I tried, one pound of raw flax was passed through the breaking machine in five minutes, which is equivalent to 120 pounds in a day of 10 hours, working at the same rate; but as I conceived the people would not do so much when they were not watched, I inquired what the average day's work was, and was told from 80 to 100 pounds *was broken*, which was afterwards proved by Mr. Prentice. I took the lowest of these quantities, thinking it right to be moderate in the computation; and as the rubbing machine works so much slower than the breaker, it just requires two rubbers to keep pace with one breaker, which may all be worked with one man and two boys; and as the finished flax

(not hackled) just yields one-fourth in weight of the raw material, so 20 pounds being the quarter of 80 pounds, is the quantity which, according to my view of the matter, would be produced by one breaking and two rubbing machines in 10 hours, worked by the above number of hands. The 40 pounds afterwards mentioned, does not allude to 40 pounds being finished for the hackle, but was in answer to a Member, who having heard that the *three* machines would conjointly do 20 pounds, it is presumed, misunderstood the statement, and thought that each individual machine would do 20 pounds at the same time. He therefore says, " They would do 60 pounds?"—The answer was, " No: 40 pounds;" and went on to say, if the breaking machine was worked a whole day, it would turn out that which, when broken, would produce 20 pounds; and 20 pounds would also be prepared by the pair of breaking machines; so that the total quantity finished is after all but 20 pounds in the day. The third child mentioned is not essential to the *working* of the above number of machines, but is necessary to attend the others, to bring and take away the materials, and must therefore be taken into the account.

In Mr. Prentice's evidence, he certainly speaks of *raw*, instead of *prepared* flax. It should state, that each breaking machine will produce from 80 to 100 pounds of *broken* flax in a day, and each rubbing machine will do half an hundred weight *of this broken flax* in the same time; and then it will be found that his evidence agrees with a sufficient degree of accuracy with my experiment. He states five, instead of three children, because he includes the hacking machine, which I do not at all allude to in the working of the machines, because, when I saw it, it was in an imperfect state.

The breaking and rubbing machines may be worked separately or conjointly, in any proportion of numbers. The dimensions of the machines may be inferred from their description, and the representations at page 335 and 339, as the scale to which they are drawn, is in both cases mentioned. As the Quarterly Journal of Science and the Arts does not profess to

advertise the inventions of any one, but merely to lay what is new and useful before the public, the price, weight, freight, &c. could not with propriety be mentioned in it, nor am I acquainted with it; but such information will no doubt be most readily furnished on application to the Patentees. I have no connection or knowledge of them, further than having been called upon professionally for my opinion of their machines, and having drawn up the Specification of their Patent which is enrolled.

JOHN MILLINGTON.

Upper Mall, Hammersmith,
21*st Sept.* 1818.

16. *Apparatus for the Distillation of Sea Water.*

The experiments lately made in France, on the use of distilled sea water for the preparation of food and for constant drink, and the success which attended them during their continuance, has added much interest to the attempts made to distil water at sea. An apparatus has lately been completed, at the Crown Foundery, Clerkenwell, by Messrs. Fraser and Chater, which promises to effect this object very successfully; and at the same time offers every use and convenience of the present ship stoves. The whole apparatus stands on a space four feet square, and is a combination of an open fire with a large boiler, ovens or roasters, and many vessels in which cooking is performed, by boiling water or steam. The boiler surrounds the fire, and supplies steam very readily and abundantly. This is conveyed, if occasion requires, into the cooking vessel; if not, into spaces which surround them, where it is condensed, and the water collected beneath.

In an experiment made with this machine, in which it was used constantly for 12 hours, it consumed only two bushels of coals; 270 pounds of eatables were cooked at once in it (it was found competent to much more), and a very large quantity of fresh water obtained.

A very ingenious mode of aërating the distilled water, is put in practice. It is made to descend, as it condenses, into

a vessel placed on a lower level, and falling on to a rough block of stone or iron, it trickles over the surface in a thin sheet. The vessel is close, except at two apertures; one of these is connected with a wide pipe, which terminates in an opening left between the steamer and boiler, where the air being heated ascends in a rapid current; the other opens to the cool air, but is continued inwards, until it nearly touches the breakwater, as it called; and thus a powerful current of cold fresh air, is rushing on to the thin sheet of distilled water, and is found to aërate it very perfectly.

It is computed, that the expense of an East Indiaman of the largest class, in casks and tonnage of water, is at every voyage, one thousand pounds; and it is supposed, that this new ship stove is perfectly competent to replace the quantity of water, purchased at this enormous expense.

II. Chemical Science.

§ 1. Chemistry.

1. *Prize Questions.*

The following Questions have been proposed by the Royal Academy of Science and Belles Lettres of Brussels. The prize for each a gold medal of 25 ducats weight.

Assuming an identity between electrical and galvanic forces, whence is it that there is not a perfect accordance between the two?

Can the truth or falsehood of the opinion that chemical and galvanic forces are the same, be proved?

The papers to be written in Latin, French, Dutch, or Flemish, and sent before February 1819, to M. Van Hulthem, Secretary of the Academy.

The Society of Pharmacy at Paris have announced the following prizes. That founded by Parmentier, of 600 francs value, to the most complete vegetable analysis: if of a substance used in Medicine, it will possess an advantage.

For a second prize of 400 francs value, 1. To ascertain the manner in which starch is converted into sugar, either by the

action of acids or of gluten: 2. To establish on facts, a satisfactory explanation of the alcoholic fermentation of substances which do not furnish sugar to the ordinary agents: 3. To point out the most favourable circumstances for the production of this kind of sugar, and of fermentation.

2. *New Vegetable Alkali.*

M. M. Pelletier and Caventou have inserted the following note in the Annales de Chimie for July. (The note was read to the Academy 10th August).

Whilst analysing the Vomica Nut, and the Bean of St. Ignace, we extracted from these two seeds the substance to which they owe their action on the animal economy.

This substance is white, crystalline, and very bitter. It crystallizes in the form of quadrangular plates, or in four sided prisms, terminated by an obtuse quadrangular pyramid. It is very slightly soluble in water, but very soluble in alcohol. It is formed like most vegetable substances, of oxygen, hydrogen, and charcoal. It is most distinguished by its alkaline properties; and though like morphium, is essentially different from it. It restores a reddened blue colour, and with acids forms neutral salts, soluble in water, and crystallizable. With weak nitric acid it forms a nitrate, but the concentrated acid acts on and decomposes it; and forms a solution, at first red, but becoming yellow, and yielding oxalic acid. Its acetate is very soluble, the sulphate less so, and crystallizable in rhomboidal plates.

This substance acts on animals in a similar manner to the alcoholic infusion of the nux vomica, but more energetically.

The class of acid vegetable substances is numerous; on the contrary, that of alkaline vegetable substances is confined to morphium. Nevertheless M. Vauquelin has noticed the alkaline properties of a substance obtained by him whilst analysing the *daphne alpina.* The new body will form another genus in the class, which may become numerous, and which has first been observed by M. Vauquelin. To recal these facts, and designate our substances by a name which will enable us to avoid periphrases, we propose to call it *Vauqueline.* This

name is better than one entirely insignificant, or that indicates properties which may be found in other bodies.

3. *New Oxy-acids.*

M. Thenard has made known a very singular set of compounds, arising from the combination of many of the acids with oxygen. They were obtained by putting the acids in contact with the peroxide of barium, and then separating protoxide of barium from the compound by sulphuric acid; oxy-acids remained.

When pure barytes is heated in oxygen, it absorbs gas to the amount nearly of the oxygen it previously contained, and a deutoxide of barium is formed. This moistened with water slakes, and falls into a white powder, evolving very little heat. The hydrated peroxide is to be diffused through 7 or 8 times its weight of water, and then acid added by small quantities at a time; the earth dissolves, and a neutral solution is obtained without the liberation of any gas. Sulphuric acid sets the acid free from this combination, and a sulphate of barytes falls, which can be readily separated.

Oxy-nitric acid obtained in this way resembles nitric acid in most of its physical properties; heated, it gives off oxygen, but is not entirely decomposed unless boiled some time. It may be considerably concentrated by placing it in a vacuum with a substance which absorbs water.

It unites to barytes, potash, soda, and ammonia, and forms neutral solutions. If heated, these salts give off oxygen, and form neutral nitrates. They are decomposed, even by spontaneous evaporation, the oxygen separating at the moment of crystallization. They decompose also in a vacuum.

The acid acts on most of the metals without the liberation of any gas, and forms nitrates with them. M. Thenard has deduced its constitution from experiments, to be 1 volume of azote and 3 volumes of oxygen.

The oxy-phosphoric, oxy-arsenic, and oxy-boracic acids are more permanent than the oxy-nitric acid, and M. Thenard hopes to obtain their salts in the solid form.

Success attended his endeavours to combine acetic acid with oxygen. The oxy-acetates formed with this acid, when heated, gave out much oxygen and carbonic acid gases.

Contrary to all expectation, an oxy-muriatic acid was also formed, the proof of which is in the following experiment: a fragment of barytes was heated in oxygen, and the quantity of gas absorbed ascertained; it was then dissolved in dilute muriatic acid, and the barytes separated by sulphuric acid. The fluid, which did not precipitate with either sulphuric acid or nitrate of barytes, was saturated with potash, and being gradually raised to the boiling point, gave out oxygen, very nearly equal in quantity to what had been absorbed by the barytes. To this proof is added the consideration, that the oxymuriatic acid obtained left no residuum on evaporation; that oxygenated barytes requires the same quantity of acid for its neutralization as common barytes; and that the muriate of barytes formed (*after ebullition?*) resembles the common muriate of barytes.

The oxy-muriatic acid has not been obtained in a very concentrated state; heated, it is decomposed, separating into oxygen and muriatic acid. Its salts decompose more readily, giving off oxygen. It dissolves zinc without effervescence; with oxide of silver there is a rapid effervescence, and oxygen is given off. M. Thenard observes, that in the oxy-muriatic acid, the hydrogen and oxygen are in the proportions necessary to form water. Its constitution therefore is 1 volume chlorine, 1 volume hydrogen, and half a volume oxygen.

By making use of the oxy-muriatic acid as an agent, M. Thenard succeeded in forming oxy-fluoric and oxy-sulphuric acids; the first process not having succeeded with these acids. The method is, to add oxy-muriatic acid to the fluate or sulphate of silver; a chloride of silver, water, and the oxyacids are formed. The oxy-sulphuric acid is easily decomposed by heat, but the oxy-fluoric acid may be boiled without decomposition.

M. Thenard states that the oxy-acids may be combined with still further portions of oxygen, and that the first process may

be repeated many times successively with the same portion of acid, and the transference each time of oxygen to it. M. Thenard verified this repetition as far as seven times; but, in consequence of this apparently unlimited power of combination, is induced to ask, whether these combinations are in definite proportions or not; and refers to future experiments for an answer.

This valuable set of experiments concludes by some very curious ones, on what may appear an inversion of the general process, the oxydation of earths by the oxy-acids. On pouring an excess of barytes water into oxy-nitric or oxy-muriatic acid, a crystalline precipitate of the hydrated deutoxide of barium was formed. It was very little soluble in water, and decomposed when heated, giving off oxygen.

Strontian and lime were also per-oxidated in the same way, and formed similar nacreous scales or crystals. M. Thenard intends to pursue the application of this method of oxidation with the other earths, and also with the metallic oxides.

4. *Boracic Acid.*

It may be observed, in connection with the changes of colour produced by acids, mentioned vol. 5, page 125, that boracic acid reddens turmeric paper in all states of dilution. When a very weak solution is used, it requires a few minutes to produce the effect; but when produced, it exactly resembles that of alkali. It has been said, that strong solutions of alkaline borates that have been made purposely acid, have become alkaline on being diluted. This has probably arisen from a careless observance of the effect above noticed, and a want of corroboration by the effect on litmus paper of the diluted solution. I find that solutions once made acid, redden litmus paper, however diluted, though at the same time they also redden turmeric paper. Paper coloured by rhubarb is not affected in this way. M. F.

5. *Benzoic Acid.*

Benzoic acid may be obtained in fine crystals by leaving an alcoholic solution of it to evaporate spontaneously. They are

flat oblique prisms, perfectly transparent, and frequently an inch in length, and the twelfth of an inch in width. They are so thin that two of the sides are scarcely perceptible. By Wollaston's goniometer, the angles of the prism appeared to be 109° and 71°. The prism is terminated by two planes set on to the lateral surfaces, and making an angle with each other of 90° by the common goniometer.

6, *Malic and Sorbic Acids.*

M. Bracconot has published a paper (Annales de Chimie, t. 8, p. 149,) containing experiments, which prove the identity of the Malic and Sorbic acids. He shews that the differences supposed to exist, depended on the impure state of the acid called malic, and its purity in the preparations called sorbic acid; but he has succeeded in obtaining the pure acid from the houseleek *(semperrivum tectorum;)* and proving its similarity with the sorbic acid. It may be observed, in addition to the facts contained in this paper, that if expressed apple juice, without any preparation except that of decantation, be left in clean leaden dishes for a week or ten days, that a separation of the impurities will take place from the acid, and a formation of crystalline malate of lead in clusters will be produced.

7. *New Inflammable Gas.*

Dr. Thomson has discovered a new compound inflammable gas, and has called it, from the nature of its constitution, hydrogurctted carbonic oxide. Its specific gravity is ,913, that of common air being 1. It is not absorbed nor altered by water. It burns with a deep blue flame, and detonates when mixed with oxygen and fired. It is a compound of oxygen, hydrogen, and carbon; and Dr. Thomson considers it as being three volumes of carbonic oxide, and one volume of hydrogen, condensed by combination into three volumes. See Annals of Philosophy, August 1818.

8. *Separation of Iron and Manganese.*

It is singular, that in the separation of iron and manganese

from each other, the old and imperfect methods, of precipitating from the sulphuric solution carefully by weak potash, of evaporating the mixed nitrates to dryness, of digesting in acetic acid, &c. should still be recommended, when Mr. Hatchett has offered so excellent a means in the use of ammonia.

The advantage of this method is, that the triple sulphate of ammonia and manganese is very soluble in water, and is not affected by excess of alkali, so that no nicety is required in the addition of the ammonia for the separation of the iron. At the same time it is necessary that there be present enough sulphuric acid to form, with the ammonia and the manganese, the soluble triple salt. If to a solution containing much manganese and little iron, excess of ammonia be added, manganese will be thrown down as well as iron, because the sulphuric acid present is not sufficient to combine with the manganese and the ammonia in the proportions required to form the whole of the manganese into a triple salt. In such a case sulphuric acid ought to be added to the solution before the ammonia. Where the proportion of iron is greater, of course there is more sulphuric acid present to combine with the ammonia, and less additional is required.

The two metals may be separated from each other by carefully adding ammonia until the solution is neutral, without advancing to the formation of a triple salt; but then the uncertainty of the exact point of neutralization occurs, and this is rendered greater, because a further addition of ammonia does not render the solution alkaline until much manganese has been precipitated. In analysis, therefore, the first method is best, though in the preparation of pure manganese and its compounds, the second is more economical, and equally certain. M. F.

9. *Observations on Gallic Acid, Tannin, &c. by M. Faraday.*

In consequence of the liability of gallic acid to change, all the processes for obtaining it are uncertain, and the results variable, either from the extreme care required, or from actual imperfection. Attempts, therefore, for obtaining the acid in

greater purity or in larger quantity may possess an interest, though they fall short of the desired point; and I am encouraged by this consideration to offer the following observations to notice, though I entertain but a very humble opinion of them.

Some bruised galls were boiled in water, together with about one sixth their weight of clipped vellum; the skin softened and gradually dissolved, forming a combination with the tannin and extract, which adhered together and was removed; more vellum was added, and boiled in the infusion, until the decanted liquor precipitated tannin. The galls and insoluble tanno-gelatine were then removed, and the infusion evaporated until adhesive. It was treated with alcohol, which formed a light brown solution, containing neither tanno-gelatine nor free gelatine. It was not pure gallic acid, but a combination of gallic acid and extract. Spontaneously evaporated, it formed crystals which were perfectly resoluble in water or alcohol, but not in ether. By repeatedly boiling ether upon them, much pure gallic acid was separated, and a substance remained which was soluble in alcohol and water, and appeared to be the extract. It still contained gallic acid.

An infusion of galls freed from tannin, or nearly so as above, after having been cooled, so that as much as possible of the tanno-gelatine should be deposited, was precipitated by acetate of lead. The gallate of lead obtained, after being well washed and dried, was placed in a flask, and muriatic acid gas obtained from dry muriate of ammonia, and concentrated sulphuric acid passed into it. The gallate was immediately decomposed, and a mixture of muriate of lead and gallic acid obtained. This mixture washed with alcohol, gave a solution which contained no extract, tannin, or gelatine, but only pure gallic acid. Another part of the mixture being distilled in a tube retort, gallic acid came over, which concreted into a solid crystalline mass, and which was very slightly coloured.

Galls in powder were digested for some days in alcohol; the solution was then decanted off, and the galls pressed: about three fourths of this alcohol was separated by distillation, and

the concentrated solution then slowly evaporated to dryness. It formed a brittle mass, easily powdered. It was mixed with about its weight of recently heated plaister of Paris, and distilled by a heat at first low, but gradually raised nearly to dull red. An angle was made in the neck of the retort not far from the body, and the beak passed into a receiver. The fumes, which contained much gallic acid with some water, passed over into the receiver, and in the angle was collected gallic acid, which concreted on cooling into a hard crystalline slightly coloured mass. The plaister of Paris in this experiment was very useful in preventing the swelling and expansion of the mass into the neck of the retort.

The gallic acid when dissolved in alcohol, and left to spontaneous evaporation, furnished transparent crystals, and it was perfectly soluble in ether. This method has succeeded with me, better than any other; and I think, will be found to yield the greatest quantity of pure gallic acid.

By evaporating the infusion of galls, nearly freed from tannin, to dryness, and then distilling (with plaister of Paris); much gallic acid will be obtained, but it is considerably diluted, and is also contaminated by a coloured empyreumatic oil.

Sir H. Davy has shewn, that the compound of tannin and gelatine is soluble in excess of gelatine, and much more in hot than in cold solutions. Dr. Bostock has proved that tan and gelatine combine in different proportions. If a compound of tannin and gelatine (tanno-gelatine) be formed with excess of gelatine, and be washed once or twice in small portions of hot water, to separate all the free gelatine, with the compound it may dissolve; there remains a substance which seems to be a mixture of two different compounds of tannin and gelatine. Heated in successive portions of water, a portion is dissolved out, which is partly deposited on cooling, and at last an insoluble substance is left, apparently always uniform in its nature. The first or soluble substance is probably a compound containing more gelatine than the second.

Tanno-gelatine is soluble in ammonia, forming a dark brown solution. If the recent solution be laid over any surface, and the ammonia allowed to volatilize; the tanno-gelatine scarcely

altered, is left behind as a film or varnish, insoluble either in water, oil, or alcohol. If the ammonia be retained in contact with it some time, it is entirely changed in its nature: a very dark brown solution is formed, which when filtered and evaporated, yields a brittle shining black substance, soluble in water and alcohol, but not in ether. It precipitates the salts of iron, tin, &c., and with the exception of its containing abundance of azote, resembles very nearly vegetable extract. It so readily yields ammonia on being heated, even before decomposition appears to have commenced, that at first a suspicion is excited of its being a compound of tanno-gelatine and ammonia.

If tanno-gelatine be boiled with corrosive sublimate in water, it becomes of a fawn colour, is more soft and pliable in the warm water, and does not become so hard and brittle as tanno-gelatine unacted upon, when exposed to the air. Its colour is also much lighter, and of an uniform brown tint. It yields corrosive sublimate on analysis, and appears to be a regular combination of it with the tanno-gelatine. In consequence of this effect, it is possible that corrosive sublimate may be found a useful agent in some of the processes for preparing leather.

10. *Gas from Turf.*

It has been proposed in Holland to substitute turf for coal, as a material, from which to obtain a gas for illumination. The experiments that have been made promise much success; and the apparatus required may be of far simpler construction than those used in the distillation of coal. The products do not require that careful and elaborate process of purification which is necessary for the gas from coal. It is said also, that the light is better. The light may be better, than that from coal gas badly made, or carelessly used; but it is is not likely that, with equal precautions, the first should surpass, or even equal the latter.

11. *Alcohol from Potatoe Apples.*

From experiments made in France at various places, it appears that the fruit or apples of the potatoe yield, by prope-

treatment, as much alcohol as an equal quantity of grapes. The apples are to be bruised and fermented with about an eighteenth or twentieth part their weight of some ferment, and then to be distilled.

12. *Triple Tartrates of Bismuth.*

There are but few soluble salts of bismuth, and perhaps not one which is not acid. The triple tartrate of bismuth and soda, may therefore perhaps be worthy attention, as it is both soluble and neutral.

If the tartrate of bismuth, which is insoluble, be boiled with the tartrate of soda, or if a super tartrate of soda be boiled with the oxide of bismuth, a solution is obtained which is perfectly neutral, and holds much bismuth in solution. It is not precipitated by alkalies nor alkaline carbonates, nor by the acids, but hydrosulphuret of ammonia throws it down. It does not crystallize on evaporation, but becomes adhesive like gum.

If nitrate of bismuth be dropped into a solution of potash or soda, the precipitated oxide is immediately redissolved on adding tartaric acid, and remains dissolved whether the solution be rendered acid or alkaline.

If cream of tartar be boiled with oxide of bismuth, a solution of the oxide is also effected, but it is difficult to procure it neutral. By adding the tartrate of bismuth to the tartrate of potash, a neutral triple soluble salt is easily obtained, which, when in solution, is acted upon by re-agents as the solution of the former triple tartrate. M. F.

13. *Tartrate of Potash and Manganese.*

Cream of tartar boiled with the white oxide of manganese dissolves it, and forms a neutral triple tartrate. This is a colourless soluble salt. The solution is not precipitated by alkalies or their carbonates, but is by prussiate of potash. If the solution be evaporated, the salt falls down in small granular crystals, which generally have a reddish tint. This salt would probably be a good source of metallic manganese.

14. *Muriate of Zinc.*

If a strong solution of the muriate of zinc be diluted, it deposites oxide; if after filtration it be further diluted, more oxide separates. The solution of the muriate of zinc is always slightly acid, and it would appear from the above effects, that it is more acid in proportion to the quantity of salt in solution, as it is more diluted. If the weak solutions be concentrated, they then will dissolve oxide, and on re-dilution will re-precipitate.

Ammonia, added to a solution of muriate of zinc, does not render it neutral until all the oxide of zinc is precipitated,

15. *Benzoates.—Benzoates of Mercury.*

Benzoic acid combines with both oxides of mercury, forming salts which are perfectly distinct one from the other. The black oxide with benzoic acid forms a salt of a dull white colour, insoluble in water or in alcohol, and yielding black oxide to alkalies. Heated, it melted and was decomposed; part of the acid flew off whilst another part was decomposed.

The red oxide heated with benzoic acid in water, gave a yellowish white salt, insoluble in water or alcohol, fusible when heated, and yielding red oxide to alkalies.

Benzoates of Iron.

There are also two benzoates of iron. The protoxide of iron recently precipitated dissolves in hot aqueous solution of the acid, and forms a salt of a light brown colour. It is slightly soluble in cold water, more so in hot water, and the solution is precipitated white by prussiate of potash. It is insoluble in alcohol. The salt thrown down by a hot solution, on cooling does not appear to be crystallized. When heated, it melts and burns with a bright flame. Ammonia and the other alkalies decompose it, and give the protoxide of iron.

The peroxide of iron combines with benzoic acid, and forms a dry heavy orange or yellow brown powder. It is insoluble in water or excess of benzoic acid, but is slightly soluble in alcohol, with which it forms a brown solution, affected by prussiate of potash and tincture of galls. Heated, it does not

melt, and it rarely burns with flame. If lighted at one part, it continues burning like touchwood. It is decomposed by the alkalies, giving red oxide of iron. The proto-benzoate absorbs oxygen on exposure to the air, and becomes a per-benzoate.

Benzoates of Zinc.

There are likewise two benzoates of zinc, but they are compounds of the same oxide. If the oxide of zinc be boiled with benzoic acid, in slight excess, two salts are formed; a super and a neutral benzoate. The super benzoate may be dissolved out by hot water, and crystallized by evaporation. It is an acid salt. It crystallizes in very small needles, or in plates. It is soluble both in water and alcohol. It is very fusible, and burns with a bright flame. Its action with alkalies and other tests, is such as might be expected from the nature of the salts.

The neutral benzoate of zinc is a white adhesive powder, retaining moisture with much force. It is insoluble either in water, or alcohol. It is decomposed by the alkalies: heated, it fuzes; it burns with flame, but not so brightly as the super benzoate.

Attempts were made to analyse these salts; but it was found so difficult, or rather impossible to dry them perfectly or uniformly, without subliming benzoic acid from them, and altering their nature, that they were resigned. M. F.

§ 2. Meteorology, &c.

1. *Meteor in America.*

A very brilliant meteor was seen in America, at the village of Vermont, near Montpellier, in the evening of Friday, the 17th of July, between the hours of 9 and 10 o'clock. It was seen to the east of the village, and passed very rapidly at first in a perpendicular direction downwards, and then horizontally to the north till it disappeared. The light was very dazzling and bright. It appeared to be as large as the full moon, and of the form of a pear, with the larger end towards the earth. At first the meteor presented the appearance of a solid body,

but immediately two large balls separated from the main body considerably behind. On disappearing, the light was compared to that of burning iron when drawn from the fire. In about two or three minutes, but as some say five or more, a heavy report was heard like distant thunder; or, as others described it, like the slow heavy rumbling of a waggon on stony ground.

2. *Meteor.*

On Wednesday, Aug. 5, about 10 minutes past 9, P. M. a most beautiful and large meteor was observed to pass over the town of Chelmsford in a north-easterly direction. Its motion was exceedingly rapid.

3. *Meteoric Stone.*

The following description of a meteoric stone, which fell in the year 1511, is taken from a set of observations on Natural History, Meteorology, &c. made in the early part of the 16th century, by Andrea da Prato, of Milan. These have not been published, but various copies of them exist. They have been commented upon by Dr. Louis Rossi, in the "Giornale di Fisica, Chemica, &c." from whence this description is taken.

"On the 4th of September (1511), at the second hour of the night, and also at the seventh, there appeared in the air at Milan, a running fire, with such splendour, that the day seemed to have returned, and some persons beheld the appearance of a large head, which caused great wonder and fear in the city. The same thing happened on the following night at the ninth hour. A few days after, beyond the river Adda, there fell from heaven many stones, which being collected at Cremasco (Crema), were found to weigh eight pounds, and even eleven pounds each. Their colour was similar to that of burnt stones."

Dr. Bossi considers this as an authentic description of the fall of an aëreolite, and accounts for the space of time which appears to have intervened between the meteor and the fall of stones, by supposing it occupied in conveying the account from Crema to Milan.

4. *Cobalt in Meteoric Stones.*

M. Stromeyer, has discovered cobalt in those masses of matter, of meteoric origin; but it is uncertain whether it is constantly present, or not. The mass in which M. Stromeyer has detected it, is that at the Cape of Good Hope; but he could find none in the specimen discovered in Siberia by Pallas, nor in that of Ellenbogen, in Bohemia. Klaproth is the only chemist who had previously observed appearances which justified the opinion that meteoric stones contained cobalt, and the stone in which he remarked it, was that which fell at Aichstaedt, in 1785.

5. *Water Spout.*

What has been called a water spout, and which, if one, must have been of immense magnitude, inundated great part of the arrondissement of Auxerre, on the 18th of June. The harvest in nineteen communes was entirely destroyed. In some places the water was six feet deep; and at Fontenai a house was thrown down and several other buildings injured. Rain, with very large hail, is described to have fallen at the time, for above half an hour.

III. Natural History.

§ 1. Zoology, Botany, &c.

1. *Locusts.*

On the cessation of a thunder storm which happened in July at Haddenham, in the Isle of Ely, the peasants of the neighbourhood found several locusts on the high-way, of full growth. The men, not knowing what they were, took them to the Rev. Mr. Pritchard of that place, who immediately recognised them. They were six inches in length, and exactly similar to those which he had seen in Egypt, and elsewhere.

2. *Locusts in the United States.*

Swarms of locusts are described to have appeared recently in Massachusetts, extending upon the right bank of Connecticut

river, 20 or 30 miles south of Northampton. It is impossible to measure the extent of the injury they occasion to timber. Many trees are now apparently dead. The female locusts are armed with a sting of nearly the third of an inch in length, and of the stiffness and point of a wire sharpened. They attach themselves to the under side of the small limbs of trees, and commence the process of *stinging*. Their progress is to the extremity of the limb, which is as distinctly marked as it could be by obliquely puncturing the limb with an awl, and so raising the awl at each puncture, as to crack the bark in a regularly continued, and, unless impeded by some obstruction, in nearly a right line. There are about three incisions to an inch, each penetrating to the heart of the limb, which are filled with small worms or eggs, of the colour or appearance of very small kernels of rice, but distinctly visible to the naked eye. Their progress, even at present, is marked by destruction, and it is impossible to appreciate its future extent.

3. *Bombice Disparate.*

The caterpillar of the butterfly *bombice disparate*, has occasioned extensive injury this summer in the neighbourhood of Agen. They first attacked the forests of cork trees between Barbaste and the village of Podenas; and having devoured both leaves and fruit, then went to the corn, which, with the forage and fruit of the country, has become their prey. The houses in the vicinity of the forests are filled with these insects; some flocks are said to have been poisoned by them, and the most dreadful apprehensions are entertained of the effects which may be expected at a future time, unless some means be devised to destroy the crysalides.

4. *American Sea Serpent.*

Another sea serpent, different to the one first seen near Cape Anne, is said to have been seen, and the following declaration has been drawn up and attested in proper form.

"I the undersigned, Joseph Woodward, captain of the Adamant schooner of Hingham, being on my rout from Penobscot

to Hingham, steering W. N. W, and being about 10 leagues from the coast, perceived last Sunday, at two P.M. something on the surface of the water, which seemed to me to be of the size of a large boat. Supposing that it might be part of the wreck of a ship, I approached it; but when I was within a few fathoms of it, it appeared, to my great surprise, and that of my whole crew, that it was a monstrous serpent. When I approached nearer, it coiled itself up, instantly uncoiling itself again, and withdrew with extreme rapidity. On my approaching again, it coiled itself up a second time, and placed itself at the distance of 60 feet at most from the bow of the ship."

"I had one of my guns loaded with a cannon ball and musket bullets. I fired it at the head of the monster; my crew and myself distinctly heard the *ball* and bullets strike against his body, from which they rebounded, as if they had struck against a rock. The serpent shook his head and tail in an extraordinary manner, and advanced towards the ship with open jaws. I had caused the cannon to be re-loaded, and pointed it at his throat; but he had come so near, that all the crew were seized with terror, and we thought only of getting out of his way. He almost touched the vessel; and had not I tacked as I did, he would certainly have come on board. He dived; but in a moment we saw him appear again, with his head on one side of the vessel, and his tail on the other, as if he was going to lift us up and upset us. However, we did not feel any shock. He remained five hours near us, only going backward and forward."

"The fears with which he at first inspired us having subsided, we were able to examine him attentively. I estimate, that his length is at least twice that of my schooner, that is to say, 130 feet; his head is full 12 or 14: the diameter of the body below the neck is not less than six feet; the size of the head is in proportion to that of his body. He is of a blackish colour; his ear-holes (ouies), are about 12 feet from the extremity of his head. In short, the whole has a terrible look."

"When he coils himself up, he places his tail in such a man-

ner, that it aids him in darting forward with great force: he moves in all directions with the greatest facility and astonishing rapidity."

(Signed) JOSEPH WOODWARD.

Hingham, May 12, 1818.

This declaration is attested by Peter Holmes and John Mayo, who made affidavit of the truth of it before a justice of peace.

The animal first seen, has, according to accounts, been observed several times since that period. On the 19th of June he appeared in Sag Harbour, and rewards were offered to the whalers to secure it. S. West, of Hallowell, master of the packet Delia, describes it as seen on the 21st of June engaged with a *whale:* and on July 2d, two persons, J. Webber and R. Hamilton, saw it about seven miles from Portland, between Cranch Island Point and Marsh Island.

The Commercial Advertiser of June 9th, contains a letter from the captain of the brig Wilson, of Salem, bound to Norfolk, wherein he states, that during his passage, off Cape Henry, he fell in with, as he at first supposed, the wreck of a vessel, when he ordered his boat to be lowered; but to his great astonishment, he found it to be the sea serpent; he says, he then examined it, and such an object he never before witnessed; he believed it to be about 190 feet in length, and its mouth and head were of an enormous size. After returning to the ship they bore off, fearing the consequences that might result from its coming in contact with the vessel.

5. *Alisma Plantago.*

The authorities from Russia are very strong in favour of the use of the Alisma plantago as a cure for hydrophobia, and the following familiar description has lately been published, that the use of the plant may become more general.

The Alisma plantago grows in water, either in marshes, lakes, or ponds. It has a capillary root, resembling that of an onion. The plant continues under water until the month of June, at the commencement of which, or even during the month

of May, in a warm climate, from five to seven long detached sprouts, of a long convex form, shoot from beneath the water. These sprouts have a reddish bark, and are each provided with a pointed, smooth, and deep-coloured leaf. In the month of June, a stalk appears, with a round green root, resembling that of asparagus. This stalk shoots from beneath the water, sometimes with, and sometimes without leaves; it is divided into several sprigs without leaves, at the extremity of each of which is a small trefoil flower, of a pale red colour, which afterwards contains the seeds. This plant is in blossom during the whole of the summer season; the latter end of August is the fittest time to gather it. The roots, when gathered, are to be washed and dried in the shade; and when used, to be eaten in powder, strewed upon bread and butter.

The plant grows in abundance on the banks of the Thames above Vauxhall Gardens.

6. *Limit of Congelation.*

It appears from information which comes from Switzerland and other alpine districts, that an opinion has partly obtained, of the increase of ice generally, and the descent of the limit of congelation. From the Tyrol, it is said, that, "In this country an extraordinary increase of the glaciers is remarked in several places. A mass of ice, which advanced from the Sindner valley, has increased from the 6th of May to the 30th of July, 76 fathoms. In many parts of Switzerland the same remark is made. Where, only one generation back, the most fertile alpine pastures were seen, there is now eternal ice; and the line of snow seems, in the course of time, to descend lower and lower from the summits of the mountains towards the plains and valleys.

7. *Lake in the Valais.*

The singular collection of waters which had formed in the Valais, in consequence of the formation of a glacier dam, in the entrance of the valley of Bagne, has at last been dispersed, but with dreadful ruin to the country around it. The works which were instituted to carry off the water in a gradual manner have not had the desired effect, but the glacier itself has been

split and broken by their weight, and they descended at once into the lower country.

It appears that the gallery, which had been cut through the glacier, conducted off the waters with sufficient rapidity at first; but that the advance of the season, at last, made the accumulations from the distant glaciers more abundant than that conveyed off. Up to the evening of the 14th of June, the gallery was effectual, but soon after the current set with such force towards the lands at the foot of the Mauvoisin, as to effect a gulph, through which a considerable body of water passed with dreadful force, breaking off and carrying away immense masses of ice and rock.

The s ntinel, terrified at the increased body of water which came from the lake, gave the alarm by the signal stationed at the foot of the Mauvoisin: it immediately reached Martigny, and every one became on the alert. A few hours afterwards, the glacier split at the entrance of the gallery to a depth of 80 feet, and an immense torrent of water rushed forth. Earth fell from all sides, and the road with the utensils, carts, sledges, and every thing upon it, was carried away.

The torrent increased on the 15th and 16th, for the gallery had been partly enlarged by the water passing through it, and was also increased in size by being ruptured, and at 3 P.M. on the 16th the lake had fallen 40 feet. But on a sudden the waters found a new passage towards Mauvoisin. The glacier, adhering there only to loose rocks, was overthrown by the waters, and at 4 o'clock gave way with a tremendous shock; the whole lake was thrown at once into the country beneath. The waters rushing out into the valley destroyed bridges, villages, cattle, and people, and traversed the lands with such rapidity, that no one was fully prepared to escape. The torrent reached Martigny in one hour and a half, having traversed a space of twenty four miles, and it there also caused dreadful devastation, from having previously been pent up between the mountains, and directed, as it were, into the town. It became divided into three columns at this point, the one passing along the base of the mountain on the side of Sion, the second, through the village, and the third along the mountain on the

side of Batia; and thus its force on entering the Rhone was greatly diminished, and afterwards it caused very little damage.

The effects of the currents of water were astonishing. Their bulk was such, that in two hours, an extent of eight leagues was covered with a body of water 8 feet deep. They carried with them masses of stone, weighing each many tons, more than a quarter of a mile. One of these masses, measured, was 15 feet long, 12 broad, and 8 in thickness. The body of water was discharged from the lake in little more than one hour; and the torrent in the immediate neighbourhood did not last much longer. The water entered the Lake of Geneva at the distance of 18 leagues, at 11 o'clock P. M.

The number of lives lost during the flood, is about 30; and above 260 houses are known to have been destroyed. The estimate of losses is at 1,109,759 francs of Switzerland, not including the expenses of re-opening a road in the valley, and the works that will be required on the Drance. Subscriptions have been opened in many places for the relief of the sufferers.

8. *Earthquakes.*

The shock of an earthquake was felt at Bencoolen, on the 18th of March; and its effects were experienced a considerable distance out at sea. Very little injury was occasioned by it.

A severe shock of an earthquake was felt in the Island of St. Thomas, on Saturday, May 16, between two and three o'clock in the morning; and another occurred at half past nine on the same morning.

The chain of the Pyrenees was agitated by movements of the earth, on the 19th of July; and several oscillations took place. Shocks of an earthquake were also felt at Pau about 7 o'clock in the morning. These effects have been associated in description with a heavy rain, and what were called great electrical explosions, which followed; as if an evident connection had been manifested between them. Stormy weather has been very frequent since the shock.

The shock of an earthquake was felt at Inspruck on the 22d July, at 10 o'clock P. M. It was very violent, lasted for some

seconds, and was accompanied by a rolling noise resembling thunder. The oscillation is described as being from West to East.

A very violent shock of an earthquake was felt at Jassy (Vienna) on the 30th of July at 4h. 44m. P. M. The shock lasted several seconds, but did not occasion much damage. A second shock, but not so violent, occurred at midnight.

A slight shock of an earthquake was felt about 1 o'clock, P. M. on the 27th August, at Albano in Italy.

9. *Magnetic Variation.*

The following observations of the declination of the magnetic needle have been published in the Annales de Chimie. They were made at Freyberg, by M. Oehlschlaegel.

	°	′	″
On May 3, 1773 (first observation) it was -	15	28	8
Jan. 8, 1813 (maximum) - -	19	22	30
From this time it began to retrograde, and on			
Jan. 26, 1815, it was - -	18	35	
March 21, 1815 - - -	18	26	
Jan. 25, 1816 - - -	18	26	
April 6, 1816 - -	18	30	
Oct. 2, 1816 - -	18	19	
Feb. 19, 1817 - - -	17	58	

§ 2. Geology, Mineralogy, &c.

1. *Organic Remains.*

Remains of the mammoth, or mastodon, and also of the crocodile, have lately been found in the Isle of Wight. The first were discovered in the parish of Motteston, and correspond exactly, in outward appearance, with those brought from the banks of the Ohio, in North America. The others were found by the Revd. Mr. Hughes, of Newport, in the parish of Northwood. They have belonged to an animal apparently not more than 12 feet in length, and are not altered in their nature.

A great number of fossil bones have been discovered at Magognano, near Viterbe. Amongst them are those of elephants, and it is said of lions, and several species of birds.

2. *Polyhalite.*

M. Stromeyer has lately analysed a substance found in the beds of rock salt, at Ischel in Austria, and has found it to be a peculiar mineral. It was before considered, and called fibrous muriacite, but has now received the name of polyhalite. It is composed of

Sulphate of lime (common)	28.74
Sulphate of lime (anhydrous) -	22.36
Sulphate of potash -	27.40
Sulphate of magnesia (anhydrous)	20.11
Chloride of sodium (mixed) -	0.19
Oxide of iron - -	0.32
	99.12

3. *Varieties of Mica.*

In consequence of his experiments on mica, M. Biot has divided that substance into two varieties. In one of these, the coloured rings produced by submitting it to polarised light are traversed by two axes in the form of a black cross, whilst in the other, they are traversed by a *second* axis, or black band passing through their centre. The first variety has smooth and brilliant surfaces, whilst the other is dull and finely furrowed. M. Vauquelin has found a chemical difference to exist between these two kinds of mica.

4. *Artificial Formation of Rock.*

Dr. Paris has given an account, in the volume of the Transactions of the Geological Society of Cornwall, just published, of the formation of a substance within a steam engine boiler, very much resembling gneiss in its appearance. He says that from its structure and appearance, it was impossible to infer its artificial origin, and that many geologists had been puzzled to know to what class of rocks it should be referred. In one part of it, metallic veins are seen penetrating its substance.

The formation of this substance is thus explained. The water which fed the boiler, was derived from the deepest part of the mine, and contained many mineral substances, both in solution and mechanical suspension: by gradual evaporation, the former bodies were deposited, as a crust in the interior of

a kettle, entangling with them fragments of mica, and of other substances, which were floating in the water of the boiler. In this manner the formation of the earthy crust may be easily comprehended, and the veins are explained with equal ease. After the deposition of stony matter, the working of the engine was suspended for several months, during which interval, the crust dried and cracked: upon its being again set to work, the water was derived from a different part of the mine, and contained pyritical, and other metallic impurities, which were deposited in the fissures, and upon the surface of the former crust. Another specimen, which Dr. Paris describes, had the interstices filled, and the surface studded, with crystals of sulphate of lime. The water, which supplied this boiler, was drawn from a mine, the country of which was clay slate, intersected by veins of pyrites, and small runners of carbonate of lime.

5. *Pure Spring Water.*

A spring of water rises in Lord Harewood's Park in Yorkshire, of remarkable purity. Its situation is at the southern extremity of the Park, between three and four hundred yards westward of the turnpike road from Leeds to Harrowgate. The Park itself is about 8 miles from Leeds, and as much from Harrowgate.

The water is scarcely affected by any tests but nitrate of silver, and oxalate of ammonia: 6 pints of it contain but 3.3 grains of dry salts, and from repeated analysis of that quantity, the following is the proportion of substances in a single pint.

The pint contains - - 0,55 of a grain, namely

Muriate of soda	-	0,325
Sulphate of soda	-	0,151
Sulphate of lime	-	0,066
Sul. Magnesia, trace of		
		0,542

§ 3. Medicine, &c,

1. *New Medical Instrument.*

A new instrument has been introduced into medical science at Paris; and, from the favourable report which it obtained, on being submitted to the Academy of Sciences, would appear to be somewhat more than a chimerical improvement.

Dr. Laennec, Physician to the Necker Hospital, supposed it likely that the various sounds which are formed in the interior of the body, as in the breast, &c. might become, from the variation induced on them by disease, indications of the state of health; and that the sounds produced by the action or motion of any particular organ, as of the heart or lungs, would point out any change in the state of that organ: and taking advantage of the superior conducting power of solid bodies, with regard to sound, he formed an instrument which should convey these indicatory sounds more readily and distinctly to the ear. This instrument is a cylinder of wood, which in some cases, according to the nature of the examination, is solid; in others, perforated lengthways by a canal; and in others, hollowed like a horn.

The voice, the respiration, sounds in the throat, and pulsations of the heart, are general indications to so many different kinds of diseases; and by one of these, among others, it is said that the existence of ulcers in the lungs, their extent, their state, and the nature and consistence of the matter within them, were ascertained.

2. *Remedy.*

Half an ounce of camphor, dissolved in a gill of brandy, and given in three parts, at intervals of three or four minutes each, is recommended as a remedy for the alarming symptoms which sometimes occur on drinking cold water when in a state of perspiration. It has been administered by Dr. John de Alton White, of New York, with success.

3. *Consumption of the Lungs.*

M. Lenthois has proposed a remedy for consumption of the lungs, which is so simple, that borne out as it is by the authority

and evidence he advances, it merits general attention. A single grain of emetic tartar is to be dissolved in a small quantity of distilled water, and then mixed with a larger quantity of water, which is to be regulated by experience; never, however, being less than 6 pints, nor more than 12 pints. This is to be used either alone, or with other drink, at meals, or at any other time, as a common beverage, and occasions no inconvenience. M. Lenthois explains this mode of proceeding by his theory, and justifies it by successful practice.

IV. General Literature, &c.

1. *Prize Questions.*

The Royal Academy of Inscriptions and Belles-Lettres at Paris, have given, as the subject of the Prize Medal of 1500 francs value, to be adjudged in 1819, "To ascertain what were the various feasts of Bacchus in the different cities of Greece, and particularly at Athens; to fix the number of those feasts, and point out the places, either in the city or without it, where they were celebrated, and the various times of the year to which they belonged; to distinguish the rites belonging to each of those feasts, and particularly those which made part of the mystical ceremonies.

The works are to be written either in French or Latin, and delivered before the first of April, 1819.

Another prize subject, to be rewarded by a medal of the same value, in July 1820, is, "To examine what was the state of government and legislation in France, when St. Louis ascended the throne, and what, at the termination of his reign, were the effects of his institutions."

The papers written in Latin or French, are to be sent to the Secretary of the Academy before April, 1820.

The following Prize Subjects are announced by the French Academy.

For the Poetical prize, which will be adjudged the 25th of August, 1819, "the Institution of the Jury in France." A Gold Medal, value 1500 francs.

A man of letters, who wishes to remain unknown, has placed at the disposal of the Academy, a Medal of 1200 francs value, as a Poetical Prize for the following Subject: "the advantages of Mutual Instruction." It will be adjudged at the same time.

A Gold Medal of 400 francs value will also be given at the same time to the author of that work which, having been published during the year 1818, shall be judged "the most useful to manners."

None but works written in French will be admitted. They are to be addressed to the Secretary of the Institution, in the usual way, before the 15th May, 1819.

Notice is also given that the Prize Question of Eloquence to be proposed next year for 1820, will be "to distinguish and compare the kinds of eloquence and the moral qualities proper for the Speaker at the Bar, and at the Senate."

2. *Roman Military Station, Haceby.*

Three apartments have been penetrated into, and partly cleared, at the Roman Military station, lately discovered at Haceby, near Grantham. They are small, but the walls are of immense strength. The middle apartment is 16 feet by 22: the others have not yet been completely examined. The walls are of coarse masonry; those on the exterior, are five feet thick; those which divide the apartments, about three feet. The floors are all paved with tessera. A few fragments of glass, supposed to be from the windows, have been found, and they are stained throughout of a fine blue colour. It would be interesting to know whether this glass is coloured by cobalt, or whether it is of the kind which the ancients tinted by copper. The process by which this last was, or could be procured, is now unknown. The remains of timber which have been found are merely fragments of charcoal, but from their peculiar appearance, it is believed the change they have suffered has been occasioned by fire, and not by time.

3. *Roman Cemetery.*

A great number of Roman urns were discovered in July last,

in a field near Eye, in Suffolk, belonging to the Marquis Cornwallis. The place had been an ancient cemetery, and the vessels were so abundant, that above 150 of them were discovered in a space of 120 square yards. They were much injured by remaining so long in the earth, and were found difficult to remove. Their height was from 5 to 9 inches; and they all appeared different in form and ornaments, the latter being of the roughest kind. They were filled with burnt bones nearly to the top, and covered with sand. The depth at which they occurred under ground was from four inches to two feet, but some were so near the surface as to have suffered from agricultural operations. Very few other things than ashes were found in the urns, but sometimes small domestic implements were picked up.

4. *Roman Villa at Bignor.*

The researches which have been made latterly at the ancient Roman villa at Bignor, have occasioned conjectures, perhaps better founded than those previously entertained respecting its early history. Bricks have been found marked L. C. C.; and the letters T. R. occur, worked in tessera. The first letters are supposed to refer to Cogidubnus, an imperial legate in the time of Tiberius, and the latter to the reign of Tiberius; and Cogidubnus is given therefore as the probable builder of this place. Another complete apartment has been discovered and cleared out; it is 4 or 5 feet below the level of the former ones, and is ornamented with an inferior sort of mosaic work.

5. *Remains of Antiquity at Sanda.*

Very extensive remains of antiquity are said to have been discovered in Sanda, one of the Orkney Islands. They consist of buildings enclosed by stone walls of above half a mile in extent. Some of them are very large, and roofed with stones of immense size. There are also several circular tumuli, each containing three graves, the greatest length of which is not more than 4 feet 6 inches. There are no traditions that at all illustrate these curious remains. They were discovered by the wind having carried away sand to a depth of more than twenty feet.

6. *Ancient Graves.*

Whilst some men were digging for chalk last July, at Great Givendale, on the road leading from Pocklington to Malton, they found several skeletons, buried about three feet deep. Two had swords laid with them; one, that had been a very large person, was laid with his head due north, and his sword upon him: the others appeared to have been buried with less ceremony, being laid nearly double. The swords seem to be double edged.

7. *Ancient Funeral Urn.*

Last month, whilst some men were working upon a new piece of road at the foot of Dunsinnane-hill, in which some remains still exist of Macbeth's vitrified fort, they found a large urn, containing several half-burnt human bones. It was a considerable depth below the surface, and appeared to have been covered by large stones. Probable suggestions are, that these remains were thus deposited after the battle which occurred near this spot in 1054, between Siward and Macbeth. The urn is at present in the hands of J. M. Naire, Esq. of Dunsinnane.

8. *Roman Pavement.*

The remains of a Roman pavement were discovered in July, at Laybach, in Illiria, equalling in beauty that discovered at Salzbourg in 1815. It is not known to what edifice the pavement belonged. An ancient Capuchin convent was erected on the spot in 1607, when no traces of building were visible. The convent has lately been demolished, and these antiquities have been brought to day light.

9. *Discoveries amongst the Pyramids.*

It is already known that M. Belzoni, of Rome, has succeeded in gaining entrance into the second pyramid of Giseh, called Chefrem. This was done on the 2d of March, and the following brief description of the interior has been published as accurate, in France.

M. Belzoni began his researches by making an excavation towards the northern front, in a direct line from the centre of the building, but finding no entrance here, further researches

were commenced about 30 feet east of the middle. On the second of March the entrance was found, being a gallery which led to a door, the whole of granite. Having raised the door, M. Belzoni entered a horizontal gallery, from whence he descended perpendicularly into a second, and from that by stone steps into a third. This last conducted him into a chamber, containing a sarcophagus, in which were embalmed human bones. Proceeding down an inclined gallery, he entered another in a horizontal direction, out of which, about half way between the extremities, a passage led towards the south into a second apartment. At the extremity of this part was a niche, cut for the reception of a door that lay near. From this place he ascended up a steep passage about 47 feet, to a stone wall, which appeared to close what had been an opening in the base of the pyramid to the exterior.

M. Belzoni concludes that the pyramids were the tombs of the Royal family of Egypt; but it is supposed that they have been plundered, perhaps by the Persians, and that thus the indications of their origin and intention have been lost.

10. *Antient Tombs.*

A peasant of Courcelles (Cotê d'Or, in France) discovered several tombs facing the east, in a field in the back of Mont Afrique, in the beginning of September. They contained bones, and the enamel of the teeth was very little altered. Two medals were found at a short distance from the tombs, the one Consular, the other of the Emperor Domitian; and a plate of copper chased and plated, which appears to have been some piece of armour. The top of this mountain was long the cantonment of Roman legions; there are still remains of an entrenchment called Cæsar's camp; and it is presumed that these graves are the resting places of some of the Roman soldiers.

11. *Dominichino's Frescoes.*

Three beautiful frescoes of Dominichino have been removed by an Italian artist, from the damp, destroying walls, of the Palace Farnese, and placed upon canvass. They are thus

saved from the destruction which was so rapidly encroaching on them, and will prove interesting examples of the advantage of this branch of art.

12. *Fine Arts.*

Florence, July. At an exhibition of the fine arts at this Court, were displayed the Casts of the Marbles which Lord Elgin brought from the Temple of Minerva, at Athens, called the Parthenon, and which now form the principal ornament of the National Museum of England. These casts are a present from the Prince Regent; in return for which, several of the finest statues in our celebrated gallery are to be modelled and sent to his Royal Highness; among them is the celebrated group of *Niobe and her Children.* The above valuable and advantageous exchanges in the fine arts, are in consequence of the suggestions of the British Envoy, His Excellency Lord Burghersh.

13. *Antique Rings.*

A beautiful gold ring was found some months since at the great gate of Carnarvon Castle, in a small silver box, with some other things, which the finder threw away. It had engraven upon it the figure of a female nursing a child, with an inscription in characters, supposed to be either Chinese or Saxon. The antiquaries of Carnarvon and Chester have not succeeded in making out the inscription.

A gold ring of very rough workmanship was ploughed up on Aug. 17, at Poringland, Norfolk; and continues, from its unknown origin, to engage the attention of antiquaries. The outer surface has eleven sides, on which are very rudely cut the letters *fides constani.* Mr. H. Bolingbroke of Norfolk, at present possesses the ring.

14. *Ancient British Coins.*

There were found in the month of August, in a field in the town land of Ballynahinch, 19 silver coins, about a shillings size each, of the reign of Henry VIII. They were all without date, though seemingly coined at three different periods; one for the city of Dublin, another for the city of Bristol, and the third with a harp, for the *kingdom* of Ireland. Though they had lain so long in the earth, they were so near the surface as to be shovelled

from between the potatoe ridges. They are in the possession of Mr. Armstrong, of Ballynahinch.

A small gold coin was dug up in the latter part of July, from among some potatoes, in the corner of a field adjoining to Moresley church-yard. It was of the reign of James I. (supposed to be a small Jacobus, of the value of 4*s.*) and was probably coined 216 years ago.

Several pieces of gold coin were recently found by some labourers employed in a potatoe ground at Barmoncourt, in the department of the Meuse. On one side of them appears a laurelled bust, with the legend: "Jacobus Dei Gratia Magnæ Britanniæ Franciæ et Hiberniæ Rex." On the reverse, round an escutcheon quartered, on which appears the arms of France, is "Faciam eos in gentem unam." The coins are of the reign of James I. who in 1603 united the crowns of England, Scotland, and Ireland, after the death of Queen Elizabeth. He was previously King of Scotland, under the title of James VI. From hence the inscription on the reverse: which however is false, as it respects France.

A number of silver coins of the reigns of Elizabeth, James I. and Charles I. were found in the end of August, by some workmen employed in opening a drain in Kilkenny: some of them are in high preservation, although they have probably lain undisturbed for nearly two centuries.

An old Roman coin was found by a farmer in one of his fields near Penrith, during the last month: on examination, it proved to be one of Faustina, the wife of the Emperor Marcus Aurelius Antoninus. Two heads of battle axes were also dug up lately near the Roman way upon the fell. They are composed of copper and brass, and very entire, and in shape somewhat resemble the head of the tomahawk of the American savages.

15. *Antient Medals.*

Some pieces of metal, supposed to be Gaulish, have been found at Vavincourt, a commune in the Arrondisement of Bar, in France. They were of gold, from 12 to 15 carats, fine, and of a concave form. On one side is a hideous head, and on the reverse, characters which have not yet been decyphered.

16. *Antient Roman Coins.*

On Tuesday, 28th July, whilst some labourers were digging a hole for the reception of a post near the New Bath turnpike, in the vicinity of Cheltenham, they found an antique jar, containing many hundreds of Roman coins, mostly copper, bearing impressions of different Emperors, and other devices. The jar was large enough to hold near half a gallon.

17. *Antient Coins in America.*

The American papers have described some coins which were found a few months since on the banks of the Elk river, in Tennessee, and which seem to indicate the existence of civilized Society in those parts, long prior to the discovery of America by Columbus. One of them has the following inscriptions on it. On one side, "Antoninnvs. Ayg. Pivs P Ptri. cos III."—On the other side, "Avrelivs Cæsar. Aug. Piii." These have been construed thus: Antonius Augustus Pius princeps pontifex Tribune tertio consule—and, Aurelius Cæsar Augustus pontifex tertio consule.

This coin, if a true one, would be of the reign of Marcus Aurelius; and, if false, the Americans still refer to the remains which exist in that country of antient fortifications, as proofs, that people at one time inhabited the country, who were far beyond the race found there by Columbus, in civilization and the arts of life.

18. *River discovered in New South Wales.*

New South Wales has been benefited by the discovery of a large navigable river in the interior, running through a country, which is described as being rich and picturesque; as abounding in limestone, slate, and timber, and having an excellent soil; in latitude 32° 45′ S. and 148° 58′ East longitude. Its course was northerly; and here it was joined by a fine river coming from the south-west. An immediate investigation of the course, and other circumstances of the river, will take place.

19. *Russian Voyage of Discovery.*

The general results of the voyage of discovery, made by the Russian ship Rurick, Captain Kotzebue, is stated to be "the

discovery of several single islands, and whole groups of islands in the south; the more exact determination of the east coast of Behring's Straits, or of the north-west coast of America, where a very extensive bay has been discovered; the correction and confirmation of previous geographical observation, with many important new ones, and a rich collection of natural history."

A very singular ice berg was fell in with by this vessel during its voyage. It was of great magnitude, and partly covered with earth and mould, so that herbs and trees were growing on it. On one part of its water line a shore had been formed, by matter washed down from above, and on this a landing was made good. A great quantity of the remains of a mammoth were found on it, in a very putrescent state. These had probably been preserved for many ages in the cold regions of the north, and were no doubt co-equal in age to those remains which the geologist finds in his later strata, and merits therefore, in a *geological sense,* the name of organic remains. The vessel brought away a number of the tusks and other parts of these animals.

20. *Plate to Dr. Paris.*

A magnificent piece of Plate, of several hundred pounds value, has been presented to Dr. Paris, by the Noblemen, Members, and Gentlemen of the County of Cornwall, as a testimony of the sense they entertain of his scientific researches during his residence amongst them. The inscription on it is as follows:—

"To John Ayrton Paris, M.D. F. L. S. Fellow of the Royal College of Physicians of London, &c. this Plate is inscribed by the Noblemen, Representatives in Parliament, and Gentlemen of the County of Cornwall, in testimony of their grateful sense of his services, in originating the plan, and promoting the institution of the Royal Geological Society of the County, which has rendered their home the school of science, and their native riches encreasing sources of prosperity."

The first volume of the Transactions of the above Society is

published, and is an early proof of the advantage and value of such an institution to that part of the country.

21. *Death of M. Monge.*

The celebrated mathematician, M. Monge, died last month at Paris, aged 70 years. He was an old and distinguished member of the Institute, and was one of those philosophers who accompanied Buonaparte into Egypt.

22. *Improvement.*

The following is an estimate made of the means of intellectual improvement in London. There are 407 places of public worship; 4050 seminaries for education, including 237 parish charity schools; eight societies for the express purpose of promoting good morals; 12 societies for promoting the learned, the useful, and the polite arts; 122 asylums and alms-houses for the helpless and indigent, including the Philanthropic society for reclaiming criminal children; 30 hospitals and dispensatories for sick and lame, and for delivering poor pregnant women; 700 friendly or benefit societies; about 30 institutions for charitable and humane purposes; about 30 institutions for teaching some thousands of poor children the arts of reading, writing, and arithmetic, on the plans of Mr. Lancaster and Dr. Bell; and these several establishments, including the poor's-rate, are supported at the almost incredible cost of one million per annum.

Plan of an extended and practical Course of Lectures and Demonstrations of Chemistry, to be delivered in the Laboratory of the Royal Institution, by William Thomas Brande, Secretary of the Royal Society of London, and F. R. S. Edinburgh, Professor of Chemistry in the Royal Institution, and of Chemistry and Materia Medica to the Apothecaries Company.

These Lectures commence on Tuesday, October 6th, at

nine in the morning, and are continued every Tuesday, Thursday, and Saturday.

Two Courses are given during the Season, which terminates in June.

The Subjects comprehended in the Courses are treated of in the following order.

Division I. *Of the Powers and Properties of Matter, and the general Laws of chemical Changes.*

§ 1. Attraction—Crystallization—Chemical affinity—Laws of Combination and Decomposition.

§ 2. Light and Heat—Their influence as Chemical Agents in art and nature.

§ 3. Electricity—Its Laws, and connection with Chemical phenomena.

Division II. *Of Undecompounded Substances and their Mutual Combinations.*

§ 1. Substances that support Combustion, Oxygen, Chlorine, Iodine.

§ 2. Inflammable and acidifiable Substances—Hydrogen.—Nitrogen,—Sulphur—Phosphorus—Carbon—Boron.

§ 3. Metals—and their Combinations with the various Substances described in the early part of the Course.

Division III. *Vegetable Chemistry.*

§ 1. Chemical Physiology of Vegetables.

§ 2. Modes of Analysis—Ultimate and proximate Elements.

§ 3. Processes of Fermentation, and their products.

Division IV. *Chemistry of the Animal Kingdom.*

§ 1. General Views connected with this department of the Science.

§ 2. Composition and properties of the Solids and Fluids of Animals—Products of Disease.

§ 3. Animal Functions.

Division V. *Geology.*

§ 1. Primitive and Secondary Rocks—Structure and situations of Veins.

§ 2. Decay of Rocks—Production of Soils—Their analysis, and principles of Agricultural improvement.

§ 3. Mineral Waters—Methods of ascertaining their contents by Tests and by Analysis.

§ 4. Volcanic Rocks—Phenomena and Products of Volcanic eruptions.

In the First Division of each Course, the principles and objects of Chemical Science, and the general Laws of Chemical Changes are explained, and the phenomena of Attraction, and of Light, Heat, and Electricity developed, and illustrated by numerous experiments,

In the Second Division, the undecompounded bodies are examined, and the modes of procuring them in a pure form, and of ascertaining their chemical characters exhibited upon an extended scale.—The Lectures on the Metals include a succinct account of Mineralogy, and of the methods of analysing and assaying Ores.

This part of the Courses will also contain a full examination of Pharmaceutical Chemistry; the Chemical Processes of the Pharmacopœiæ will be particularly described, and compared with those adopted by the Manufacturer.

The Third and Fourth Divisions relate to Organic Substances. —The Chemical changes induced by Vegetation are here inquired into; the principles of Vegetables, the Theory of Fermentation, and the character of its products are then examined.

The Chemical History of Animals is the next object of inquiry —it is illustrated by an examination of their component parts, in health, and in disease; by an inquiry into the Chemistry of the Animal Functions, and into the application of Chemical principles to the treatment of Diseases.

The Courses conclude with an Account of the Structure of the Earth, of the changes which it is undergoing, of the objects

and uses of Geology, and of the principles of Agricultural Chemistry.

The applications of Chemistry to the Arts and Manufactures, and to œconomical purposes, are discussed at some length in various parts of the Courses; and the most important of them are experimentally exhibited.

The Admission Fee to each Course is Four Guineas; or by paying Eight Guineas, Gentlemen are entitled to attend for an unlimited time.

Life and Annual Subscribers to the Royal Institution are admitted to the above Lectures, on payment of Two Guineas for each Course, or by paying Six Guineas, are entitled to attend for an unlimited time.

Further particulars may be obtained by applying to Mr. Brande or to Mr. Fincher, at the Royal Institution, 21, Albemarle-street.

Medical and Chemical Lectures.

On Monday, Oct. 5th, at 9 in the morning, at No. 9, George-street, Hanover-square,

Dr. Pearson's Lectures on the Practice of Physic, with the Laws of the Animal Economy; and will be continued at that hour every succeeding Wednesday and Friday.

On Tuesday Oct. 6th, at 9 in the Morning, at the Royal Institution, Professor Brande will commence his Lectures on Chemistry, including Medical Jurisprudence; which will be continued every succeeding Thursday, Saturday, and Tuesday at the same hour.

On Wednesday, Oct. 7th, at 8 in the Morning, Dr. Pearson will commence his Course on Therapeutics with Materia Medica, in George-street.

Perpetual Pupils, who have paid their admission to either of the Lectures, are free to both.

Art. XIX. Meteorological Diary for the Months of June, July, and August, 1818, kept at **Earl Spencer's** Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY.
for June, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Monday	1	50	72	29,90	29,88	W	W
Tuesday	2	45	74	29,90	29,90	W	W
Wednesday	3	47	75,5	29,94	29,95	W	S
Thursday	4	45	80	30,03	30,07	SbE	ESE
Friday	5	46	77	30,19	30,20	ESE	ESE
Saturday	6	45	75	30,25	30,22	E	E
Sunday	7	49	70	30,22	30,19	NE	NE
Monday	8	48	72	30,19	30,19	E	E
Tuesday	9	50	72,5	30,19	30,13	ENE	EbS
Wednesday	10	48	76	30,13	30,10	NE	EbS
Thursday	11	48	81	30,07	29,99	E	E
Friday	12	53	79	29,97	29,87	ESE	SE
Saturday	13	52	81	29,87	29,80	W	W
Sunday	14	56	72	29,87	29,90	NW	ENE
Monday	15	48	78	29,97	29,89	SE	W
Tuesday	16	55	77	29,89	29,78	W	WbS
Wednesday	17	59	71	29,68	29,60	W	NbW
Thursday	18	52	73	29,66	29,66	NW	WbN
Friday	19	46	72	29,70	29,55	W	WbS
Saturday	20	52	63	29,50	29,68	WbS	W
Sunday	21	45	65	29,88	29,79	W	W
Monday	22	55	68	29,68	29,60	SW	W
Tuesday	23	50	65	29,65	29,78	W	W
Wednesday	24	52	69	29,80	29,90	W	W
Thursday	25	53	76	29,97	29,87	WbS	W
Friday	26	55	77	29,90	29,95	W	W.
Saturday	27	46	79	29,84	29,62	S	SW
Sunday	28	53	70	29,62	29,90	SW	W
Monday	29	47	74	30,04	30,08	W	W
Tuesday	30	45	77	30,13	30,07	W	W

METEOROLOGICAL DIARY
for July, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Wednesday	1	51	73	30,08	30,00	W	NW
Thursday	2	52	70	30,00	30,00	NE	SE
Friday	3	48	71	30,10	30,06	E	NW
Saturday	4	57	69	30,00	30,00	NW	NW
Sunday	5	55	71	30,00	29,97	NW	WbN
Monday	6	48	77	30,00	29,98	W	SE
Tuesday	7	50	80	29,91	29,77	SE	SE
Wednesday	8	54	77	29,77	29 88	W	NW
Thursday	9	48	71	30,00	30,00	NW	W
Friday	10	56	75	30,00	29,90	W	NNW
Saturday	11	48	74	29,90	29,80	W	W
Sunday	12	60	73	29,70	29,70	NW	WbS
Monday	13	59	73	29,75	29,90	W	NW
Tuesday	14	50	80	30,10	30,12	W	NE
Wednesday	15	56	76	30,20	30,18	EbN	EbS
Thursday	16	58	81,5	30,18	30,10	W	W
Friday	17	57	79	30,10	30,04	SE	SE
Saturday	18	52	79	30,04	29,90	E	E
Sunday	19	53	80	29,90	29,98	NE	WbS
Monday	20	60	72	29,90	29,88	NW	W
Tuesday	21	48	75	29,88	29,70	W	W
Wednesday	22	57	78	29,90	29,97	W	W
Thursday	23	54	81,5	30,00	29,90	WbS	SE
Friday	24	61	86	29,80	29,70	SE	SE
Saturday	25	60	82	29,70	29,70	SSE	SW
Sunday	26	61	82	29,73	29,70	SE	SE
Monday	27	60	79	29,73	29,86	SE	WNW
Tuesday	28	48	68	30,10	30,12	NW	NW
Wednesday	29	50	77	30,12	30,08	WbS	W
Thursday	30	58	82	30,04	30,04	WbS	WbS
Friday	31	61	77	30,00	29,90	SW	W

METEOROLOGICAL DIARY

for August, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Saturday	1	57	69	29,90	29,93	W	NW
Sunday	2	54	76	30,08	30,02	E	SE
Monday	3	46	76,5	30,02	29,98	SE	SE
Tuesday	4	52	80	30,00	29,97	SE	SW
Wednesday	5	50	84	30,00	29,90	SE	SW
Thursday	6	65	74	29,97	30,00	W	WbN
Friday	7	51	79	30,00	30,00	WbN	NW
Saturday	8	56,5	76	30,00	29,97	W	W
Sunday	9	53	77,5	29,92	29,83	NE	NE
Monday	10	58	69	29,88	30,00	NE	E
Tuesday	11	42	68	30,12	30,12	NE	E
Wednesday	12	45	69	30,10	30,05	E	E
Thursday	13	49	70	30,09	30,09	E	E
Friday	14	49	64	30,07	30,07	NE	NE
Saturday	15	54	67	30,07	30,07	NE	NE
Sunday	16	50	69	30,04	29,99	NW	NW
Monday	17	47	68	30,00	29,93	NW	WNW
Tuesday	18	48	68	29,90	29,89	W	E
Wednesday	19	47	64	29,89	29,92	N	NE
Thursday	20	45	64	29,97	29,97	W	W
Friday	21	52	68	29,97	29,97	WbN	NW
Saturday	22	50	63	29,97	29,98	NW	ENE
Sunday	23	40	67	30,10	30,10	NW	NW
Monday	24	52	66	30,10	30,00	W	W
Tuesday	25	53	65	30,00	29,98	W	W
Wednesday	26	51	66	29,90	29,82	W	W
Thursday	27	52	65	29,75	29,60	W	W
Friday	28	60	69	29,54	29,60	W	W
Saturday	29	53	74	29,80	29,83	W	WSW
Sunday	30	56	70	29,74	29,80	SW	W
Monday	31	45	67	29,90	29,76	SE	SW

Select List of New Publications during the last Three Months.

Botany and Horticulture.

Transactions of the Horticultural Society of London, 4to. vol. III. Part I.

Prodremus; or a General Nomenclature of all the Plants, indigenous and exotic, cultivated at the Southampton Botanic Gardens, arranged alphabetically. By W. B. Page, 8vo.

The Science of Horticulture, including a practical System for the management of Fruit Trees. By Joseph Hayward, Gent. Illustrated with Plates, 8vo. 12*s.*

Chemistry.

A Treatise on the General Principles of Chemical Analysis. Translated from the French of L. J. Thenard. By Arnold. Merrick, 8vo. 12*s.*

The Chemical Catechism; with Notes, Illustrations, and Experiments. By Samuel Parkes, F. L. S. &c. 8vo. 8th edition; greatly enlarged, and for the most part re-written. 14*s.*

Medicine, Anatomy, and Surgery.

General Views relating to the Stomach, its Fabric and Functions. By J. C. Speer, M. D. 8vo. 5*s.*

Pharmacophœia in usum Nosocomii a Thoma Guy, Armigero, A. D. 1721, frindati, 18mo. 4*s.*

Pharmacopœia Nosocomii Regalis Sancti Thomæ Londinensis.

Observations on the Treatment of Epiphora or Watery Eye, and on the Fistula Lachrymalis; together with Remarks on the Male Catheter, and on the Treatment of Hæmorrhoids. A new edition. To which are added, Observations on the near and distant Sight of different Persons; on the Muscæ volitantes of Nervous persons; and on the Staphyloma, Hydrophthalmia, and Carrinoma of the Eye. By the late James Ware, F. R. S. Edited by his Son, Martin Ware. 8vo. 8*s.*

Practical Observations on the Treatment of the Diseases of the Prostrate Gland, illustrated with Copper Plates, &c. By Sir Everard Home, V. P. R. S. vol. II. 8vo. 14*s.*

Report of the Committee of the London Infirmary for curing Diseases of the Eye, occasioned by the Statements contained in a Letter addressed by Sir William Adams, to the Governors of Greenwich Hospital. 8vo. 3*s.* 6*d.*

Reply to the same, by Sir William Adams. 8vo. 1*s.* 6*d.*

Observations on the properties of the Air Pump Vapour Bath, pointing out their efficacy in the cure of Gout, &c. &c. By M. La Baume. 8vo. 2*s*. 6*d*.

Observations, with Cases illustrative of the sedative and febrifuge powers of Emetic Tartar. By W. Balfour, M. D. 8vo. 3*s*. 6*d*.

Observations, proving that Dr. Wilson's Tincture for the cure of Gout and Rheumatism is similar, in its nature and effects, to the deleterious preparation, the Eau Medicinale. By W. Henry Williams, M. D. F. L. S. 4to. 4*s*.

The Art of preserving the Feet; or practical Illustrations for the prevention and cure of Corns, Bunnions, &c. By an experienced Chiropodist. 8vo. 5*s*. 6*d*.

On the Nature and Treatment of Tetanus and Hydrophobia; with some Observations on the natural classification of Diseases in general. By Robert Reid, M. D. 8vo. 7*s*. 6*d*.

An Address to British Females, on the moral management of Pregnancy and Labour. By William Cooke, Surgeon Accoucheur. 8vo. 3*s*. 6*d*.

The Hunterian Oration, delivered before the Royal College of Surgeons, on Saturday Feb. 14, 1818, and published at their request. By Sir David Dundas, Bart. one of the Governors of the College. 4to. 5*s*.

Observations on Strictulous affections of the Bowels, and on some varieties of Spinal Disease: with an appendix of cases. By J. Bradley, M. D. 8vo. 8*s*.

A Memoir on the congenital Club Feet of Children, and on the mode of correcting that deformity. By Antonio Scarpa. Translated from the Italian by J. H. Wishart. With Plates, 4to. 10*s*. 6*d*.

Practical Observations on the action of Morbid Sympathies, as included in the pathology of certain Diseases. By Andrew Wilson, M. D. 8vo. 9*s*.

An Essay on the symptoms, causes, and treatment of Inversio Uteri; with a History of the successful extirpation of that organ, during the chronic stages of the Disease. By W. Newnham, Esq. 8vo. 7*s*.

A Succinct Account of the contagious Fever of this Country, as exemplified in the Epidemic now prevailing in London; with the appropriate method of Treatment, as practised in the House of Recovery. By Thomas Bateman, M. D. 8vo. 6*s*.

Surgical Essays. By Astley Cooper, F.R.S. Surgeon to Guy's Hospital; and Benjamin Travers, F. R. S. Surgeon to St. Thomas's Hospital. Part I. 8vo. With Plates. 10*s*. 6*d*.

Elements of Anatomy, designed for the use of Students in the Fine Arts. By James Birch Sharpe, Member of the Royal College of Surgeons, and Student in the Royal Academy. With Plates. Royal 8vo. 10*s.*

A Manual of Practical Anatomy, for the use of Students engaged in Dissections. By Edward Stanley, Assistant Surgeon, and Demonstrator of Anatomy at St. Bartholomew's Hospital, 1 vol. 12mo.

Anderson and Cheese, Medical Booksellers, 40, West Smithfield, have just published their Annual Catalogue of Books on Anatomy, Medicine, Surgery, Midwifery, Chemistry, Botany, &c. &c. new and second-hand; including an extensive Collection of Foreign publications recently imported. A complete List of the Lectures delivered in London, with their terms, hours of attendance, &c. &c. &c.

Mineralogy, Natural History, and Geology.

On the Safety Lamp for Coal Miners, with some Researches on Flame. By Sir Humphry Davy.

A Selection of Facts from the best Authorities, arranged so as to form an outline of the Geology of England and Wales; with a Map, and sections of the Strata. By W. Phillips, M. G. S. 12mo. 9*s.*

A New Descriptive Catalogue of Minerals; with an engraving and explanation of the Hydraulic Blow-pipe, and Lapidaries apparatus. By J. Mawe. 12mo. 3*s.*

A Treatise on Rivers and Torrents, with a method of regulating their course and channels. To which is added, an Essay on Navigable Canals. By Paul Frisi, Professor Royal of Mathematics at Milan, F. R. S. London, &c. Translated by Major General John Garstin, of the Bengal Establishment. 4to. 1*l.* 11*s.* 6*d.*

The Second Edition of the Elements of Conchology, according to the Linnæn System; illustrated by 28 plates, drawn from nature. By the Rev. E. T. Burrows, A. M. F. R. S. F. L. S. Mem. Geol. Soc.

Topography.

The Scientific Tourist through England, Wales, and Scotland; by which the Traveller is directed to the principal objects of antiquity, art, science, and the picturesque, &c. &c. By Thomas Walford, Esq. F. A. S. F. L. S. 12mo. 2 vols. 12*s.* With coloured Maps, 14*s.*

A Brief Description of the Borough and Town of Preston, and its Government and Guild, with Notes. By J. Taylor, 8vo. 4*s.* 6*d.*

Observations on the State of Ireland, principally directed to

its Agriculture, and Rural population; in a Series of Letters, written on a Tour through that country. By J. C. Curwen, Esq. M. P. 8vo. 2 vols. 1*l.* 1*s.*

A Journey round the Coast of Kent, containing Remarks on the principal objects worthy of notice throughout that interesting border and the contiguous district, including Penshurst and Tunbridge Wells, with Rye, Winchelsea, Hastings, and Battle, in Sussex; being notes made during a summer excursion. By L. Fussell, Esq. With a Map, 8vo. 9*s.*

England described; being a concise delineation of every county in England and Wales; with an account of its most important products, notices of the principal seats, and a view of the transactions, civil and military. By John Aiken, M. D. 8vo. With a map, 14*s.*

A New History and Description of York. By W. Hargrave. 3 vols. royal 8vo. 1*l.* 11s. 6.

VOYAGES AND TRAVELS.

Narrative of a Voyage to Senegal in 1816, undertaken by order of the French Government; comprising an account of the Shipwreck of the Medusa, the sufferings of the crew, &c. By J. B. H. Savigney, and Alexander Correard. 8vo. With Plates, 10*s.* 6*d.*

Narrative of a Residence in Algiers; comprising a geographical and historical Account of the Regency, biographical sketches of the Dey and his Ministers, anecdotes of the late war, observations on the relations of the Barbary States, with the Christian powers, and the necessity and importance of their complete subjugation. By Signor Peinanti. With Notes and illustrations, by Edward Blaquiere, Esq. R. N. 4to. 2*l.* 2*s.*

Letters of a Prussian Traveller, descriptive of a Tour through Sweden, Prussia, Austria, Hungary, Istria, the Ionian Islands, Egypt, Syria, Cyprus, Rhodes, the Morea, Greece, Calabria, Italy, the Tyrol, the Banks of the Rhine, Hanover, Holstein, Denmark, Westphalia and Holland. Interspersed with Anecdotes of distinguished Characters, and illustrations of political occurrences. By John Bramsen, 8vo. 2 vols. 18*s.*

Voyage of His Majesty's Ship Rosamond, to Newfoundland and the Southern Coast of Labrador. By Lieut. Edward Chappell, R. N. 8vo. 12*s.*

History of the Island of Saint Domingo, from its first discovery by Columbus to the present period. 8vo. 12*s.*

A Journey from England to India, through Persia, Georgia, Russia, Poland and Prussia, in the year 1817. By Lieut. Col. Johnson, C. B. With Plates. 4to. 2*l.* 2*s.*

A Second Journey through Persia to Constantinople, between the years 1810 and 1816. With a Journal of the Voyage by the Brazils and Bombay, to the Persian Gulph; together *with* an *Account* of the proceedings of his Majesty's Embassy, under his Excellency Sir Gore Ousely, Bart. K. S. L. By J. Morier, Esq. late His Majesty's Secretary of Embassy, and Minister Plenipotentiary to the Court of Persia. With maps and coloured engravings. Royal 4to. 3*l.* 13*s.* 6*d.*

Travels in Canada and the United States of America, in 1816 and 1817. By R. F. Hall, Esq. late Military Secretary to General Wilson, Governor in Canada. 8vo. 14*s.*

An Autumn near the Rhine; or Sketches of Courts, Society, and Scenery in some of the States bordering on the Rhine. 8vo. 14*s.*

A Journal of Travels in the United States of North America, and in Lower Canada, performed in the year 1817, by John Palmer; containing particulars respecting the price of land and provisions, remarks on the population and country, &c. 8vo. 12*s.*

Letters from Illinois. By Morris Birkbeck. 8vo. 5*s.*

Travels through the United States of America, in the years 1806, 1807, 1809, and 1811, with corrections and improvements till 1815. By John Mellish. With plates, 8vo. 8*s.*

Narrative of a Journey in the Interior of China, and of a Voyage to and from that country, in the years 1816 and 1817; containing an Account of Lord Amherst's Embassy to the Court of Pekin; and Observations on the countries which it visited. By Clarke Abel, F. L. S. Illustrated by Maps and other engravings. 4to. 3*l.* 3*s.*

Spanish America; or a Descriptive, Historical, and Geographical Account of the dominions of Spain, in the Western Hemisphere, continental and insular. By R. H. Bonnycastle, Captain in the Royal Corps of Engineers. Illustrated with Maps. 8vo. 2 vol. 1*l.* . *s.*

Literary Intelligence.

Dr. Spiker, one of the Librarians of his Majesty the King of Prussia, who recently visited this country for literary and scientific objects, has published in German, the first volume of his Tour through England, Wales and Scotland. The work will extend to three volumes, a Translation of which will be published here under the authority, and with some additional Remarks by the Author.

THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS.

Art. I. *Observations on the Medico-Chemical Treatment of Calculous Disorders.* By W. T. Brande, *Sec. R. S. &c.*

[The following Remarks have hitherto formed a part of my Lectures on the Materia Medica, and are now published at the request of many Gentlemen who attended the Course. The chemical History and Treatment of Calculi will follow in a future Number.]

If there be any branch of physic which can be called philosophical, it is that which relates to the treatment of calculous complaints; for in it, the offending substances can be collected and analysed, and the effects of medicines unequivocally judged of by their increase, change, or disappearance.

There are very few cases in which chemical principles are successfully applicable to the treatment of disease; but the only rational observations which have been given to the public concerning the causes and treatment of these affections, have originated with chemists and chemical physicians. Of the remarks of Paracelsus, Van Helmont, Stahl, Boerhaave, and others of their school, it will be unnecessary to say more than that they are vague, incorrect, and absurd; though Fourcroy, with that useless diligence which characterises many parts of his great work, has laid more stress upon their notions than mere historical relation required.

In 1776 Scheele pointed out the existence of a concrete acid in urinary calculi; and that illustrious chemist may be considered as the first writer whose observations on the chemical constitution of calculi are entitled to any notice. In 1798, Dr. Pearson prosecuted the enquiry which Scheele had opened; and his researches were published for that year in the Philosophical Transactions. But it was in 1797, that the most important addition was made to our knowledge upon this very important subject, by the publication of a masterly paper by Dr. Wollaston, in which we are not only made acquainted with the existence of several new substances in urinary calculi, but also with some highly valuable facts respecting the treatment of cases in which they occur. Yet, with this light upon the subject, medical and surgical practitioners remained, with few exceptions, grossly ignorant, and continued to graft their own erroneous views upon the errors of their predecessors: they neglected the valuable body of chemical evidence which had been adduced, and till within these few years, scarcely any person appeared moderately informed upon the subject, apparently for the want of some connected and popular view of all that had been done, so digested and arranged, as to be intelligible to medical men. This desideratum Dr. Marcet seems to have supplied, in his Essay on the Chemical History and Medical Treatment of Calculous Disorders; and the medical world, as well as the public at large, should feel much indebted for the perspicuous and useful manner in which he has fulfilled his task.

The object of the present essay, is to throw the most important facts connected with the chemico-medical treatment of these disorders, into a yet more popular form, with a view of exciting attention to the simple principles of their early treatment, and of shewing the dangerous consequences of delaying an easy prevention, where cure is impossible, except by the manual operation of the surgeon.

In the year 1808 I undertook, at the request of Sir Everard Home, to examine the collection of urinary calculi, contained in the splendid Museum of the College of Surgeons; and the

observations which that examination suggested, were presented to the Royal Society, with the addition of some valuable remarks by Sir Everard Home, and the whole honoured by a place in the Philosophical Transactions for 1806. In some subsequent papers, also presented to, and published by that learned body, we have jointly prosecuted different branches of the same enquiry; and in the present digest, I propose to give a sketch of all that is important in these papers, illustrated by such other facts and observations as have since presented themselves.

Section 1. *Some General Observations on the early Symptoms of Gravel, and on the modes of treating them.*

It is of the utmost importance that the early symptoms of gravel should be carefully attended to; for we are often able with little difficulty, to check their progress, and to form useful anticipations of the probable duration and extent of the complaint. It is in this stage, and this only, that we may rationally speak of solvent medicines; and that it is really in our power to prevent that kind of accumulation which ends in stone either of the kidney or bladder. The only medical writer who has candidly and sensibly discussed this very important part of our present subject, is, as far as I know, Dr. Marcet, in the last chapter of his valuable essay already quoted; but as my own views upon this subject differ in some points from those which he has there propounded, I shall beg leave to state them in general terms.

It is necessary to bear in mind, that of the numerous substances contained in the human urine, there are rarely more than three which make their appearance in the form of deposit or gravel; these are phosphate of lime, phosphate of ammonia and magnesia, and uric acid. The two former substances constitute a *white* sediment, the latter forms a *red* deposit; and it is above all things necessary clearly to distinguish between the two, and not to confound them, as many practitioners are apt to do, under the general name of *gravel*, or *sand*. The urine,

in its healthy state, is always an acid secretion; and this excess of acid retains the earthy salts, above alluded to, in a state of solution; but whenever this inherent or natural acidity of the urine is diminished, whether by disordered digestion, irregular secretion, particular kinds of food, or improper medicines, a tendency to form the white deposit immediately ensues. When from any cause, this white sand is observed, the internal use of acids will, in most cases, diminish or remove it; this is a fact of the utmost importance in its treatment, for which we are indebted to the discoveries of Dr. Wollaston, in this branch of chemical medicine.

Concerning this white sand, there are two questions of importance. The first relates to the circumstances of its appearance; the second to the mode of treating of it.

White sand is very frequently symptomatic of disordered digestion, and is apt to appear in any case where excess in eating or drinking has been committed. It often seems to be produced by the free use of amylaceous or farinaceous diet. It may always be abundantly formed by alcaline medicines, and persons who habitually drink soda water, or take magnesia, are frequently voiding it. Its appearance, in the latter cases, has often led to serious errors. I have known soda water exhibited in a case of stone in the bladder, *produce* abundance of white sand, which the ignorance of the patient and his medical attendant, led them to refer to the solvent power of the medicine upon the stone, which they thought was gradually giving way and being voided; whereas, great mischief was doing, by giving the urine more than its usual tendency to deposit the phosphates, and consequently to augment the size of the calculus; for it deserves particular remark, that the urine has a natural tendency to deposit the above-mentioned phosphates upon any extraneous body in the urinary passages, and often upon the inner coat of the bladder, if it be at all diseased.

The use of magnesia will also occasion the deposit of the phosphates by the urine; and I have heard the white sand described as magnesia passing off by urine.

The tendency of the urine to deposit white sand whenever

its natural acidity is diminished, is shewn by the addition of a little alcali to recently voided urine, which immediately throws down a white powder.

The acids naturally in excess, or uncombined, in healthy urine, and which may be regarded as holding the earthy phosphates in solution, are the phosphoric, the uric, and the carbonic. Berzelius has stated the lactic acid to be one of these, but my own experiments do not induce me to coincide in the opinion of that active chemist. Dr. Marcet has controverted my idea respecting the uniform presence of carbonic acid, (Essay, page 159, note) but, whenever I have made the experiment in the way he mentions, that is by exposure under the exhausted receiver of the air pump, I have procured it in some quantity; and whenever I have added baryta water to recently voided urine, the precipitate, immediately separated, has contained carbonate of baryta.

The appearance of white sand does not seem deserving of much attention where it is merely occasional, and where it follows indigestion brought on by accidental excess; if, however, it invariably follows meals, and if it be observed in the urine, not as a mere deposit upon cooling, but at the time the last drops are voided, it becomes a more serious disorder, for it is sometimes the forerunner of other forms of the disorder; sometimes it creates much irritation, and sometimes may even collect and concrete into a calculus, more especially if the complete evacuation of the bladder does not take place. I have known it considered as the *effect* of irritable bladder, where it has, in reality, been the *cause*.

In these cases then, the best mode of treatment, both for cure and prevention, becomes the next subject of enquiry; and acid medicines are, in most cases, properly and effectually resorted to. It will first be right to consider the *kind* of acid most effectual, and afterwards to notice cases in which acids are hurtful.

The mineral acids, namely the nitric, the sulphuric, and the muriatic, have each been employed; and there are perhaps particular cases, in which one is more proper than the others;

but, they are all of them improper in cases where there is much irritation of the urinary passages; and as they are apt to produce this, though effectual in checking the formation of white sand, they require to be cautiously exhibited, and their effects prudently watched over.

The *nitric acid* may be exhibited in doses of from five to twenty drops night and morning, or thrice a day. It may be taken in plain or barley water. From ten to thirty drops of the dilute sulphuric acid, and from five to twenty of the muriatic acid may be taken in the same way; that is, diluted till they become palatably acid.

Of these acids the nitric is perhaps most apt to disagree, and to occasion those symptoms of indigestion which are announced by flatulency, and eructations; and in a few particular cases, its long continued use has rendered the stomach reluctant as to food, though many instances might be cited of its tonic effects, as a promoter of digestion and encreaser of appetite.

The *sulphuric acid* may most properly be termed a *tonic*; it generally admits of being longer persevered in than either of the others; it seldom gripes or nauseates, and almost always promotes the functions of the stomach, where they are sluggish or irregular.

The *muriatic acid* agrees, in most cases, with the stomach, but not so with the bowels, which always become more relaxed during its use, than where the other acids are employed; this circumstance, however, often recommends it, for constipation very frequently attends the state of body which favours the formation of white sand; and hence aperient medicines are alone adequate, in some cases, to suspend or prevent the disorder.

Where the mineral acids agree, they are usually very effective, and in a few days they diminish, or entirely prevent the formation of the sabulous deposit; but where they disagree, they rather increase its quantity, or they tend to the production of a mucous secretion, probably from the coats of the bladder, which envelopes, and is voided with the sand; and which, in particular cases, may certainly tend to increase the risk of its

agglutination, and of the formation of a concretion in the bladder. The mineral acids too, almost always disagree with children, who are equally liable with adults to an increased secretion of the phosphates, and in whom prompt and effectual treatment is equally requisite to prevent the formation of stone in the bladder.

Here then recourse must be had to another mode of treatment, namely to the vegetable acids.

The *tartaric acid*, either in its pure form, or as it exists in *cream of tartar*, may be used in pretty liberal doses; of the former, from five to twenty grains, and of the latter, from twenty to forty or sixty grains may be used, either dissolved in barley water, or administered in any convenient vehicle. The cream of tartar is more apt to relax the bowels than the tartaric acid; a circumstance, which, as has been hinted above, often tends to its beneficial efficacy.

The *citric acid*, however, seems on the whole preferable to the tartaric: it may be given in the same way, in doses of from five grains to half a drachm; it rarely proves inconveniently purgative, and is very effectual in modifying the secretion of urine.

Cases are by no means uncommon in which a white sabulous deposit in the urine, often going to a great and alarming extent, appears symptomatic of, or in some way connected with irregularity of the biliary secretion; pain in the region of the liver, sallow complexion, whitish brown and dry tongue, are its usual concomitants in these cases; and there is a very troublesome irregularity of bowels, generally tending to costiveness of an obstinate kind; sometimes succeeded by or alternating with relaxation. I have known persons returning from warm climates, in this predicament, and upon being questioned as to their complaint, gravel and sand are usually uppermost in the mind. They often have recourse to the solvents of *empyrics*, which, with very few exceptions, are strong alcaline solutions; or they consult medical men, who, hearing of the sand, and inadvertent as to its kind, prescribe soda water, solution of potash, magnesia, and the like ordinary preventives. This

alcaline treatment invariably does harm; the patient's digestion, already feeble, becomes more impaired; the sand previously perhaps small in quantity, is rendered abundant; the bowels pass from occasional to constant irregularity, and every symptom becomes slowly, but mischievously, and in many cases, irretrievably augmented. Cases of this kind I describe with the more confidence, having seen several. I allude to them now as particularly improper in most cases for the mineral acids in large doses, whereas, by the vegetable acids they are always greatly benefited. But in these, and a number of similar cases, the best and simplest plan of treatment, is not to employ medicine, so much as diet; to adopt a general acid system; to abstain from soda water, and all alcalis; to refrain from malt liquor; to take weak lemonade, and an occasional glass of cyder as ordinary drink at meals; if accustomed to wine, to prefer Champagne and Claret to Madeira or Port, but to take little of either; if the bowels remain constipated, to take a drachm or two drachms of Epsom salt in a half pint tumbler of luke warm water in the morning fasting, or what is more pleasant, to stir a tea-spoonfull of magnesia into an occasional glass of sour lemonade; to eat salads and acid fruits, and more especially oranges, which in this state of things are an heroic remedy.

I have said that there are few cases in which the vegetable acids, properly administered, produce any aggravation of the symptoms, or where they can be said to disagree; yet such cases do occur, and a very copious deposition of white sand shall be attended with a peculiar irritability of bladder (independent of calculus, for those cases I propose afterwards to consider) which is aggravated by any of the above-mentioned acids, and yet in which they are most decidedly indicated. In a paper which I presented to the Royal Society in 1812 (Philos. Trans, 1813, p. 213) and in which I have detailed some cases illustrative of the operation of acids in preventing the white deposit, I have spoken of the beneficial effects of *carbonic acid*, where, from peculiar circumstances, the other acids disagree; and since that period several cases have occurred, attended by

equally beneficial results. The mode of exhibiting this acid is, either simply dissolved in water, in which case it may easily be prepared by the patient in a *Nooth's apparatus*, or procured from the dealers in artificial mineral waters; or it may be administered in the form of a saline draught in the state of effervescence, as by dissolving thirty grains of carbonate of potassa, and twenty grains of citric acid, in separate tea-cups of water, mixing the solutions in a large tumbler, and drinking the whole during the effervescence. This dose may be repeated two or three times a day, or oftener, if expedient.

It may now be asked in what manner the acids which have been mentioned, act. Do they pass off by the kidnies, and produce a direct effect upon the urine by rendering it more acid and capable of retaining the phosphates in solution; or do they act indirectly, upon the digestive and assimilating organs, so as to modify the action of the kidneys, and consequently to affect their secretion. In my communications to the Royal Society, I have briefly discussed this question, which, though undoubtedly curious, does not appear practically important; and I have now little to add upon the subject. The experiments which I made on the passing off of carbonic acid by the kidneys, I have since repeated with similar results. The recently voided urine was introduced into a phial, furnished with a bent tube, passing into lime water, and the whole apparatus put under the receiver of the air pump. I invariably found carbonic acid evolved during the exhaustion, and observed its quantity to be greater after drinking liquors containing it in an uncombined state. I am quite aware of the uncertainty of experiments of this kind, and of the ever varying composition of the urine, but I cannot give up the opinion that the existence of a large quantity of carbonic acid in the stomach is connected with its secretion in the kidneys.

I have stated above that the uncombined carbonic acid of the urine often acts an important part in retaining the earthy phosphates, but more especially the ammoniaco-magnesian phosphate, in solution; and its escape is, in these cases, attended by the deposition of the triple salt, in the form of a

film upon the surface of the urine, the cause of which was first pointed out to me by Dr. Wollaston.

I have already adverted to the importance of attending to the diet in cases of white sand, and to the necessity of keeping the bowels open by the occasional use of mild aperients, where the acid regimen alone is insufficient. It frequently happens, I believe, that much of the benefit of the mineral acids may be referred to their mere tonic effect, to mending the digestion, and thus improving the general state of health. The febrile affections of children are very frequently attended by an apparently alarming deposit of white sand in the urine, and a dose of calomel will often carry off both the fever and the sand. It is thus too, that air and exercise, bark, bitters, and mineral tonics, are often successfully resorted to in urinary complaints of the kind we have been considering.

Having now considered the nature of the white sand, and the mode of treatment to be adopted in regard to it, we may advert to the composition of the red sand or gravel, and to the means which are most effectual for its prevention and cure. Here, as in the former case, distinction must be made between those cases, in which the sand is actually *voided*, and in which it is deposited, after some hours, by the urine, which at first was clear. The appearance of the red sand, in the former case, is an alarming indication of a tendency to form calculi; in the latter, it is often a temporary symptom of indigestion; but yet, if it frequently occurs, means should be strenuously adopted for its prevention.

Since the discovery that the red sand consists of uric acid, more or less pure, and of the solubility of that acid in the caustic fixed alkalies, these substances have been in vogue as solvents. The important fact, however, was soon made out, that the alcaline subcarbonates, and carbonates, were equally effectual, and less apt to disagree with the stomach than the pure alcalis; and as in them the uric acid is not soluble, it became pretty evident that the benefit of alcaline medicines was not rationally referable to their solvent powers. Indeed, where the caustic alcalis are taken, they could never reach the

urine in a caustic state, but would naturally combine with the carbonic or other acids of that secretion.

Experience having sufficiently shewn the efficacy of the alcalis, and alcaline carbonates in preventing an increased secretion of uric acid, the first question that arises is, as to the *kind* of alcali to be preferred, and the *state* in which it should be exhibited.

Soda seems by common consent to be preferred to potash; and there can be little doubt that although it will be most effectual in a pure form, it is most prudent to use it in its highly carbonated state, as it is sold under the name of soda water; for it may be longer persevered in, and is less apt to injure the digestive organs in that state than in any other. It deserves remark, however, that much of what is sold under the name of *soda water*, contains scarcely any soda, but is merely water impregnated with fixed air; and further, that it is very apt to be contaminated by copper, zinc, or lead, arising from the vessels in which the condensation is carried on. These contaminations, which are very easily discovered by proper tests, have been adverted to by Mr. Pepys in his "Description of an improved Apparatus for the Manufacture of Soda Water," published in the 4th volume of this Journal.

But, though soda water is in most cases very effectual, in others it is certainly less so than a similar solution of *potash*; and I have seen cases in which the latter alcali has dispelled symptoms that withstood the operation of the former. This fact has been adverted to by Sir Gilbert Blane, in his paper on the Effects of large doses of the Vegetable Alcali in Gravel. (*Transactions of a Society for Improving Medical and Chirurgical Knowledge.*) He has there also proposed the convenient method of partly saturating the alcali with lemon juice or citric acid, and has dwelt upon the advantages of combining opium with it, which are certainly great in cases attended by irritation or other symptoms calling for the use of sedatives.

Ammonia, and *sub-carbonate of ammonia*, are alcaline remedies of considerable use in many cases of red gravel; they may be resorted to with advantage where symptoms of indigestion are brought on by the other alcalis; and appear to be of great

use in that form of red gravel which is connected with gout, and which, in gouty patients, often alternates with fits of the disease; the joints and the kidneys appearing to be affected by turns.

In a paper which I communicated to the Society for the Improvement of Animal Chemistry in the year 1809, and which has a place in the Philosophical Transactions for 1810, I have detailed the advantages of *magnesia* as a preventive of uric gravel; and subsequent experience, which has been pretty ample, completely justifies the character I have there given it. I do not mean to propose it as excluding the alkalis; it is indeed improper in many cases where they may be properly employed; but where potash and soda have been so long employed as to disagree with the stomach, to create nausea, flatulency, a sense of weight, pain, and other symptoms of indigestion, magnesia may be adopted with the greatest chance of success.

The doses of the different alcaline remedies that have been enumerated, and the modes of exhibiting them, may next be briefly noticed.

The caustic alkalis are best taken in any mucilaginous vegetable infusion; barley water or water gruel, for instance; and their nauseous flavour is much covered by liquorice. From five to sixty drops of the *liquor potassæ* of the London Pharmacopœia has been called a dose. From ten to twenty drops may be considered an average dose, taken night and morning, or thrice a day in a glass of barley water. A drachm of the carbonate of potash, as advised by Sir Gilbert Blane, or of the carbonate of soda, may de dissolved in two ounces of water sweetened with honey, and taken during the effervescence, occasioned by the addition of half an ounce of lemon juice, twice or three times daily.

Soda water should be kept in the shops, single, double, and treble; the first should contain one, the second two, and the third, three drachms of the crystallised subcarbonate in the pint; and from one to three half pints of either may be taken daily, as it proves agreeable or efficacious. A portion of the alcali in the strongest may be conveniently neutralised by

adding a table spoonful of lemon juice to each half pint tumbler, which renders it more palatable.

From half a drachm to two drachms of the solution of ammonia of the pharmacopoeia may be taken in a sufficient quantity of water; but the sub-carbonate is as effectual, and has the advantage of being administrable in the form of pills, in which it may be united with some bitter extract; none better than that of camomile. Twenty grains of the alkaline sub-carbonate, and a drachm of the extract may be made into twenty-four pills, two or three for a dose, twice or thrice a day.

Magnesia may either be calcined, or the sub-carbonate; the latter is generally preferable, except where the stomach is distended by wind, and in that case calcined magnesia should be used. The dose is from ten to thirty grains of the calcined, and from twenty to forty or fifty of the sub-carbonate, or as it is often called, common magnesia. This remedy is particularly commendable, where the alcalis have been employed for a long time, where they excite flatulency and indigestion, or disagree with the bowels, or where the red sand continues to be formed even during their copious use. As magnesia sometimes collects in and clogs the bowels, their state should be attended to during its use, and any accumulation which may have occurred, occasionally moved off by a mild aperient, or by the occasional use of acids, where they are admissible, The case described by my brother, in the first volume of this Journal, will give an idea of this effect, and point out the requisite caution in the use of magnesia.*

The next subject of enquiry is the mode in which the alcalis operate.

That it is not by any solvent power upon the gravel after it is formed, is evinced by the action of the carbonates, and by that of magnesia, which though incapable of dissolving uric acid, are as effectual in checking its formation as the caustic alcalis. It would appear then that the benefit derived from

* Magnesia may be dissolved in excess of carbonic acid, and administered in the form of magnesia water, which is an excellent substitute for soda water. Some years ago Mr. Schweppe at my request prepared it in this form.

these medicines, must be principally ascribed to their action upon the digestive organs, where, by preventing the formation of, or neutralising and combining with acid matter, it is probable that they prevent its secretion in the kidneys. Nevertheless, the alcalis undoubtedly do pass off by urine; and in a paper already quoted (Philosophical Transactions, 1810) I have detailed some experiments illustrative of this subject, the results of which are extremely important, as connected with the treatment of calculous dirorders, for they shew the danger of administering alcaline remedies, where there is a tendency to the production of the phosphates; and the likelihood of producing the deposition of white sand, by improperly persevering in their use, after the formation of the red sand has been checked.

The above are the principal observations which have occurred to me, connected with the symptoms and treatment of the white and red sand: the first object should be to ascertain the nature of the matter voided; the next to select the most appropriate acid or alcali, and in either case to watch carefully over their effects, since the acids, after having removed the superabundance of the phosphates, will sometimes induce the excess of uric acid; and nothing is more common than the appearance of white sand during the use of alcaline medicines.

Cases are by no means unfrequent, in which the sabulous deposit of the urine consists of a mixture of uric acid with the phosphates; as far as my analysis has gone, the sediment of inflammatory disorders is usually of this kind; it is very frequent in the urine of those persons who habitually indulge in excess of wine; and not uncommon in jaundice and other affections of the liver, where a large quantity of albuminous mucus often accompanies it. This form of the disorder is generally alleviated by general rather than particular treatment; I mean by particular attention to the state of the stomach and bowels; by purges, and by tonics. I have heard nitric acid recommended, upon the principle of its dissolving both uric acid, and the phosphates; and in some cases which were under Dr. Pemberton's care in St. George's Hospital, and of which I have preserved notes, it appeared particularly efficacious; I am

however induced to refer its efficacy rather to its tonic than its solvent powers. Indeed, it cannot be too often repeated, that in all cases of urinary sand and gravel, it is necessary to pay particular attention to the general state of the patient's health, and along with the medicines usually called solvents, to pursue a tonic and invigorating plan in respect to the stomach.

The best diet for those who suffer from excess of uric acid, and who form red gravel, has been a subject of discussion with most writers upon this disorder, and animal and vegetable food has been alternately extolled and recommended. I should not hesitate in these cases to recommend the adoption of a vegetable diet, for, independently of the valuable observations of Dr. Wollaston, connected with the subject (Philos. Trans. 1810)* I have known a week's abstinence only from animal food relieve a fit of uric gravel, where the alcalies were of little avail; and in other cases the same plan has been most successfully adopted; at the same time it must be remembered, that if flatulency and other stomach symptoms arise from the want of usual animal diet, mischief will in most instances result.

The observations which I have now made are intended to refer to those cases of sand and gravel which are independent of the formation of calculi, and unconnected with any sabulous accumulation in the kidneys or bladder. In these cases new questions and difficulties arise, to which it will next be proper to advert.

[*To be continued.*]

---

* In this paper, Dr. Wollaston has alluded to the quantity of uric acid contained in the excrement of birds feeding solely upon animal matter. The following is a curious analogous fact. Mr. Barrow lately put into my hands for examination, a red matter, which tinges the snow in high latitudes, collected by Capt. Franklin, in the late Polar expedition. It was supposed to be the seeds of a lichen, but I found it to contain uric acid, separable by potash, and precipitable from its alkaline solution by muriatic acid, in the form of a yellow powder. The uric acid is mixed with what appears a modification of the same substance, having many of the properties of what Dr. Marcet has called *xanthic oxide*.

Art. II. *Treatise on Cryptogamous and Agamous Vegetables; concluded from* p. 31.

Filices, or Ferns.

This group includes the largest vegetables known among those, where no sexual organs have been demonstrated. Many of the species have a long capillary radication, from which the tuft of leaves arises. Many others a root of progressive formation, the aggregate of the bases of the leaves produced and destroyed in annual rotation. In some the stem is sarmentose, running along the surface of the ground, or climbing the nearest support; others have a perpendicular trunk or stipe, scored round with large scars, the vestiges of the fallen foliage; these, by their port, remind us of palms of the middle size. Their leaves are of great variety of form, but are all at first bent in the shape of crozier or pastoral staff, and covered with membranous scales, which drop off as the blade unrolls itself.

The conceptacles or parts of fructification are produced on the under side of the blade of the leaves, along the nerves and veins, or else at their extremity. When these are very numerous, which is commonly the case, they congregate into distinct bodies, forming patches, varying in dimensions and contour in the different species. These groups of conceptacles, which are denominated *sori*, originate under the epidermis or scarf skin, sometimes raise up small portions of it, and serve as the involucres, technically termed *indusiæ*. The blade is covered with miliary glands, and is frequently furnished with hairs of every various shape and consistence.

The conceptacles are either of a crustaceous, or a membranous texture, sometimes naked, sometimes with a lid, or sometimes encircled by an elastic ring; they open by two valves, or rend irregularly, and are filled with very fine seminula, which are yellow or white, or colourless, spherical, ovoid, pyramidal, &c. &c. smooth, or beset with salient points.

The conceptacles with a ring, are those which are most

entitled to our attention: they form a membranous one-celled perfectly close pouch, encircled either wholly, or in part, by a narrow padded fillet, composed of salient cells, placed end to end. It is this fillet which is called the ring. When a conceptacle is come to maturity, the ring stiffens, and bends itself back with a force that tears the pouch, and expels the seminula. It sometimes happens, that the first effort is not sufficient to discharge the whole of the seminula, and some remain behind among the fragments of the pouch; but the action of the ring depending upon an hygrometrical property, it extends and contracts, as it is either moist or dry, and always concludes by discharging the whole of the contents. The seminula, sown upon a moist soil, disengage themselves, according to some writers, from a real tunic, and produce, by way of cotyledon, a green rounded sinuated leaflet, without any nerves, that applies itself to the surface of the soil, which it lays hold of by a long slender hair that issues from one of the points in its circumference, from which point the crozier shaped plumule also rises.

Though nothing has been detected in the ferns to which the function of a stamen can be attributed, still the majority writers have not been able to bring themselves to class plants of this magnitude in the agamous division of vegetation. Baissed by their prejudices, they have formed their opinions without any very scrupulous regard to analogies. Thus, according to Micheli and Hedwig, the hairs upon the young leaves are stamens; according to Stehelin, Hill, and Schmidel, the rings of the conceptacles; according to Gleichen, the miliary glands; to Kœlreuter, the indusiæ.

Algæ, or submerged Plants.

This group consists of a multitude of different plants belonging to morasses, lakes, brooks, rivers, springs, and seas. Their structure admits of their being developed only under water; exposed to the air vegetation ceases, and they dry up; though

many revive when restored to the water before the action of he air has destroyed their texture.

With Mons. Lamouroux, we view the Algæ as consisting of two principal divisions: *Thalassiophytes*, which inhabit the sea and other briny waters, and *Confervæ*, which grow in fresh water. But, as in all attempts to class according to system, the objects of natural history, some defective point is sure to present itself, so neither is the present exempt from objection. A small number of species, whose conformation does not admit of their separation from the marine Algæ, grow with the Confervæ in fresh water; and I shall be much deceived, if the Confervæ, which Mons. Lamouroux does not admit among his Thalassiophytes, have not, on the other hand, their representative types in the bosom of the ocean. However diligent and laborious, the botanist of the present day has shewn himself, yet this branch of his study still remains behind the others; though the mist that envelopes it is beginning to clear away.

Thalassiophytes are subdivided by Mons. Lamouroux into those with, and those without, articulations. The plants generally comprehended under the term of sea-weeds, are either of an herbaceous, a woody, a cartilaginous, a membranous, or a horny consistence; their cellular parenchyma or spongy flesh, variously enlarged, and assuming the form of a frond at the upper part, contracts at the lower into the dimensions of a stem, ending at the base in a kind of foot or stand, by means of which, they take root in, and lay hold of, the solid bodies on which they grow. In the centre and circumference of the substance of the stem, we find large irregular cells, and in the intermediate space, a layer of narrow elongated cells; and it is this structure which Mons. Lamouroux, the most successful observer of these vegetables, deems, in some respects, analagous to that of the stems of the dicotyledons, and as justifying us in surmising a correlative developement between the two sorts of vegetables. In other respects, the Thalassiophytes cannot be said to have any vessels; except we

choose to denominate such, these simple cavities of the cellular texture.

Their frond, which is red, yellow, brown, or green, according to the species, is often furnished with nerves that come from the stem, and are the ramifications of the elongated cells. These fronds, which may be likened to the leaves of the terrestrial vegetables, have, however, a different appearance from the herbaceous parts produced within influence of the air; a difference easier to perceive than to express, consisting not so much in the form as in the substance. They may be likened to cartilages, to pieces of parchment, fine horny laminæ, cut out into the shape of lobes, strips, or leaves.

Reproduction is carried on in the Thalassiophytes, through the medium of seminula, usually contained in elytræ, of various figures. The elytræ are sometimes enclosed in cells contained in the cellular texture, and are only disseminated by the rupture of that; sometimes they are enclosed in conceptacles peculiar to themselves, which at first are quite close, and only burst on maturity, or else have originally a small conduit at their summit, a kind of oviduct, open at the surface of the frond, where there is a small aperture termed the *ostiolum*. They are almost always enchased in the body of the frond, and filled with a gelatinous substance, in which the elytræ are seen to float; are either scattered without order, or formed into regular groups, according to the species; or else, and that not unfrequently, they are congregated in hollow tubercles, that shoot out into the form of a spike or ear at the summits of the plant.

Out of a multitude of the more remarkable sea-weeds, we may select the *Claudea* of Mons. Lamouroux, as an instance of a most extraordinary structure. Its shorny transparent frond is carved into numerous small ones, pierced through with holes, and resembling little pieces of lace mounted at the side upon brass wires bent into the form of a bow. Its membranous spindlelike conceptacles are of a coral red, and attached by their ends to the parallelly disposed nerves of the frondlets. They contain angular elytræ, collected in spherical

groups. Elytræ of the same kind have been observed in a pretty large proportion of the Thalassiophytes, by Messrs. Lamouroux, Mertens, and Dawson Turner: who are also agreed, that several of the species which have them, have besides these, the sort of conceptacles which we have described before; and Mons. Lamouroux, in particular, has gone so far as so shew that their two-fold mode of reproduction occurs only in that division of the Thalassiophytes, where the species have no joints.

This double mode of reproduction reminds of the same in the Lycopodiaceæ. Is this merely an analogy in appearance, or can there be a real and essential relation between the Thalassiophytes and the Lycopodiacæ, in regard to their means of reproduction? A question for the solution of those naturalists who make cryptogamous and agamous plants their peculiar study.

The seminula of the Thalassiophytes, on leaving their conceptacles, frequently attach themselves to the surface of the frond which has produced them, or else to some neighbouring one, and there develop themselves. Nothing so common in this class of vegetables as accidental parasites.

The germination of the seminula of the Thalassiophytes has been investigated by Messrs. Gunner, Stackhouse, and Lamouroux. It is not clear, that these minute seeds have any genuine tunic, and in my opinion, the apparatus they first put forth, can in no way be made out to be similar to the cotyledons of the vegetables provided with leaves.

The mucilage which envelops the seminula assists in their development. This has been proved by Mons. Lamouroux, by a very simple and ingenious experiment. Fresh water has the property of dissolving this mucilage; salt-water does not act upon it. Mons. Lamouroux washed the seminula with both fresh water and salt water in separate parcels; the first lost their germinating faculty, the second suffered no injury, and vegetated under his eye. The same ingenious observer has discovered, that no one species will vegetate indifferently upon all sorts of substances; that one species will succeed only

upon calcareous sand, another upon siliceous sand, another upon granite, schistus, marble, &c. &c.; and he concludes from these facts, that the roots of sea-weeds draw their nutriment from the soil on which they grow. In this he dissents from the opinion of the majority of botanists, who assume that the root or stand of these Algæ, merely serves to moor them in their places, and prevent their being the sport of the waves.

The surface of the frond, in some species, is covered with points radiated with short whitish jointed hairs. Réaumur, who was the first to attend to these hairs, held them to be secretory organs, and denominated them *stamens*, a word, the precise meaning of which, had not then been fixed. Some of our more modern botanists have read this opinion in the works of Réaumur with so little attention, that they have conceived him to have taken these pencils of hair for the male organs, while, in truth, he was one of those who doubted the existence of the sexes, even in those plants which are furnished with undoubted pistils and stamens.

Linnæus looked elsewhere for the stamens in the Thalassiophytes. Several of them are furnished, independently of their conceptacles, with *ampullæ*, a kind of cavities distended with air, and which serve to diminish the specific gravity of the plants, and assist in keeping them at the surface of the water. Some interwoven filaments contained in these vegetable swimmers, and which are, beyond a doubt, the fragments of an internal cellular texture, were deemed by him to be the supporters of the pollen.

Later times have witnessed the rise of a third opinion, the last resource of the botanists, who maintain that there can be no germ of existence without previous impregnation, and yet admit the want of sexual organs in sea-weeds. They say, that the mucilage in which the seminula float, is a spermatic liquid, and that impregnation is immediate, nearly in the same way, according to some zoologists, as the fœtus of oysters and muscles is impregnated. We must allow, that though it may be impossible to demonstrate the falsehood of this

opinion, yet that it is not less so to adduce a single fact in its support; and that it falls among the crowd of those theories which add nothing to the stock of real knowledge.

The Thalassiophytes of an herbaceous green, especially those of the genus Ulva, when exposed under water to the action of the solar light, give out a considerable portion of oxygen gas, as is done by the herbaceous parts of the phænogamous vegetables.

A great quantity of vegeto-animal matter is procured from sea-weeds, and they are the only things in which *iodine*, supposed to be one of the simple or primitive substances, has been found. As it is against the rules of sound reasoning to admit that iodine is created by the mere power of vegetation, so it is evident, that it must be derived from some extraneous source; although Messrs Davy and Gaultier de Claubry have not been able to detect it in sea water, and it has not been found by any analysis to be present in the soils on which sea weeds grow. In fact, the discovery of the origin of iodine still remains to be made.

Several of the Thalassiophytes become covered by a substance resembling the crystallized sugar of manna.

The fresh water Algæ, usually comprised under the general denomination of Confervæ, present us to the full with as many interesting appearances as the Thalassiophytes. They sometimes fasten themselves to the soil by a radical stand or claw, but are oftener quite detached, and float about at the mercy of the water. They grow into extremely fine threadlike forms, whose structure cannot be brought within our view without the aid of the microscope: through this instrument we perceive that every thread is hollow and membranous, that it is either simple, or branching, and that its cavity is either continuous throughout, or else transversely partitioned at certain intervals. We find the same structure likewise in some of the marine Algæ. The Confervæ multiply themselves by indefinite development and separation of parts, and many have besides, seminula enclosed within the threads, or else in their proper conceptacles.

The hydrodictyous Confervæ do not appear to be endowed with this last mode of regeneration. These vegetables, which grow in fresh water, like some we shall speak of presently, are elongated pockets formed of a net-work, with pentagonal meshes. After a certain time, the fine threads that compose each pentagon, separate from one another, swell out, and extend themselves, becoming, finally, five reticulated pouches, each resembling exactly the one which the five formerly constituted. The new pouches, in their turn, are multiplied by the separation and development of their meshes; and thus the race of the species is perpetuated.

The polyspermous Confervæ of Mons. Vaucher, contain, in branching and partitioned tubes, seminula, which are at first transparent, and disposed like beads in a string. These, as they ripen, become opaque, and detach themselves from one another, then the cells of the tube burst, the seminula spread themselves abroad, and soon produce new Confervæ.

The ectospermous species, which constitute the genus named *Vaucheria,* are furnished at the surface of their tubes with globular conceptacles, from the side of which appendages sprout in the form sometimes of a club, sometimes of a hook, or at others of a simple salient point, and which, according to M. Vaucher, are stamens filled with the fecundating matter; but which Sprengell, with greater appearance of probability, looks upon as merely so many proliferous shoots. Every conceptacle contains a single seminulum; the germination of which has been traced by Vaucher.

To that naturalist as well as to Messrs. Dillwyn, Charles and Romain Coquebert, we owe the knowledge we have of those extraordinary productions we call *Conjugatæ (Conjugées)*, ranked, perhaps indeed erroneously, among the Confervæ. In them the tubes do not divide into branches: but are partitioned, and contain small grains arranged one behind the other in a double cross spiral line. When these tubes remain in an insulated position, they grow without multiplying themselves; but when they come very near to one another, they unite themselves by a real copulation, and give birth to new *Conjugatæ.* The process

goes on as follows: every cell of the tubes puts forth at the side an excrescence which is hollow and transparent like the tubes themselves; the excrescences of two corresponding cells lengthen themselves out, till they meet each other, when they cement themselves together end to end, and form a channel of communication; by means of this channel, the grains of one cell pass into the other and mingle themselves with those already there; the whole of these unite themselves into a small mass of either a roundish or an oval shape; when the walls of the cells burst open, and the little mass, now set free, begins to open itself into two lobes, from the centre of which a slender thread comes out and presently shews itself with all the features of the parent plant. The cells of a same tube form their conjunction indifferently to the right or to the left, so that it often happens that three tubes are united together parallelly. Every tube is capable of either discharging or receiving the grains; and often while one cell is filling, the adjoining one is emptying, whence it has been inferred that all the tubes are furnished with male and female organs; but that, as in the instance of the snail, they cannot impregnate themselves. Though we suspect that a tube doubled together, in such way that the two halves might be in contact with each other, would produce the same effect upon itself as two distinct tubes would upon themselves.

If we attend only to the conformation of the Conjugatæ, we shall not be induced to separate them from the Confervæ, but their copulation, the ejection of grains, the commixture and aggregation of these for the formation of an egg, are phenomena which seem to place them beyond the boundaries of the vegetable kingdom, at the same time that their features present us only faint and doubtful analogies with the animal creation.

Lichens, or Liverworts.

The variation of form in the Liverworts is very extensive. They shew themselves sometimes under the appearance of an

extremely fine powder, a scaly, or a farinaceous crust, sometimes like a foliaceous lamina, extended horizontally or standing vertically, somtimes they assume the likeness of horns, threads, funnels, or small trees more or less branched; some adhere to the surface of the rock, destroying the smoothness of its polish, and forming a firmly fixed crust over it; others take their stand upon walls, upon the ground, upon the trunks of trees, or hang down like long beards from the branches; and we find among them every shade of colour from the dullest to the gayest tint.

The parts of the Lichens are distinguished by the technical denominations of *Thallus, Fibrillæ, Podetium, Pulvinuli, Cyphellæ, Conceptacles, Sporulæ,* and *Soredia,*

The *Thallus* is the frond of the Lichens, and bears their fructification either immediately or intermediately by the intervention of a particular support. Its consistence is subject to great variation; it is either powdery, granular, horny, gelatinous, stringy, or membranous, and sometimes divides into *lobioli,* small jaggs something like leaves in shape.

The *Fibrillæ* are the fine thready roots which come from the thallus, and hold it to the bark of the tree, the ground, or the rock.

The *Cyphellæ* are small circular bordered cavities, which are found at the under surface of the thallus of species of the genus called *Sticta.*

The *Pulvinuli* are the threads, somctimes simple, sometimes branched like little tree-like excrescencies, which we see at the upper surface of the thallus of the lichens, called *Lecidea.*

The *Podetium* is a small stalk or stem, either simple or branched, which rises from the thallus of a great many of the species and bears the conceptacles.

The variation of form in the conceptacles is too extensive and distinct to be comprised in any general description. We shall follow the example of those who have attended the most to the subject, and take a separate view of each of the

principal forms, designated by their proper terms. We may reckon ten sorts of conceptacles belonging to lichens:

1. The *Pelta*. This is developed at the edge of the thallus; is enclosed in a thin gelatinous membrane, which soon disappears; its surface is broad and flat, its consistence coriaceous; it has either no rim, or one that is very inconspicuous (see *Physcia*).

2. The *Scutella*. This is a sort of conceptacle that shews itself at first like a simple pore at the surface of the thallus, then grows gradually larger and larger until it forms a little disk, bordered round by the substance of the thallus itself (see *Patellaria*).

3. The *Orbilla*. This is borne on a podetium; grows out and widens into a disk, in the same way as the scutella, only the substance of the podetium which forms the rim, is here extended either into *ciliæ* or *radii* (see *Usnea*).

4. The *Patellula*. This is distinguished from the scutella, because instead of the rim formed out of the thallus, it is surrounded by a stuffed or solid fillet, produced by the enlargement of its own substance (see *Variolaria*).

5. The *Mammula*. This as well as the scutella and patellula originates from the thallus, but has a more convex form than those two conceptacles, and has neither rim nor fillet (see *Coniocarpon*).

6. The *Cephalodium*. An inflated highly convex conceptacle without rim or fillet, and originating from the podetium (see *Stereocaulon*).

7. The *Gyroma*. This forms upon the thallus an orbicular protuberance traced with salient plaits in spiral lines, which burst longitudinally, and set free conceptacles furnished with eight seminula each (see *Umbilicaria*).

8. The *Globulus*. This sort of conceptacle is globular; it originates at the extremity of the podetium, into the substance of which one half of it is immerged. It detaches itself at last and falls off in due time, leaving behind it the little cavity it had filled before (see *Isidium*).

9. The *Pilidium.* This is orbicular or hemispherical, and its surface resolves into a powder by which the plant is reproduced (see *Calycium*).

10. The *Cistula.* A kind of orbicular conceptacle, in its young state perfectly close; it is situated at the top of a podetium, from the substance of which it is formed. It bursts irregularly when ripe, and discovers in its centre a fungous substance full of fibres, and which served as the placenta of seminula congregated into little masses (see *Sphærophorus*).

The existence of seminula in the Lichens is not disputed; the powder which covers the surface, or is lodged in the substance of the conceptacles they produce, has been generally held to be such; though there are several writers who take that powder, notwithstanding its minuteness, for groups of elytræ, every one of which contains infinitely smaller seminula. Up to this day however no elytræ have been clearly made out, except in the kind of conceptacle termed *gyroma.*

Many of the lichens multiply their race not only by seminula, but likewise by propagula, which group themselves in various parts of the plant, and form powdery patches, termed by most of the later Botanists *soredia.* This powder, which consists of the fragments of the thallus or else the podetium, has been designated by Linnæus as well as Hedwig and several of their disciples as the *male flowers.*

No lichens are of an herbaceous substance, though several are green and give out oxygen, under the same circumstances as leaves do. Their texture is entirely cellular, without the least appearance of any thing vascular. In the solid podetium a woody filament invested by a loose rind, is very plainly made out. Mr. Ramond observes that in the place where a lichen is wounded, the substance which was originally white turns to green; a transition which he attributes to the extravasation of coloured juices that are then set free from their peculiar cells; but is it not more likely to be caused by the combination which takes place between the oxygen of the atmosphere and the substance of the lichens?

Hypoxyleæ.

This group connects by nature so intimately with that of the lichens, that we have no means of defining with precision the limits which separate the two.

Sphærulæ and *Lirellæ* are the denominations of the concepticles proper to the hypoxyleæ. *Sphærulæ* are either rounded, oblong, or conical; they open at the top by chinks or pores, and sometimes each of itself constitutes the entire plant; their seminula, which are of a mucilaginous consistence, disseminate themselves abroad in the form of a jelly, which drought reduces to a very fine powder. *Lirellæ* are narrow, elongated, and frequently ramified; they open by a longitudinal fissure, and contain polyspermous elytræ. *Sphærulæ* and *Lirellæ* are often supported by a thallus, which is sometimes dry and crustaceous, at others thick and of a corky substance; in the last case it is distinguished by the denomination of *stroma,* and sometimes takes the appearance of a frond. Certain species, while young, present upon their surface a white kind of powder, not improbably analogous to the *soredia* of the lichens.

These vegetables are chiefly found upon the stems, branches, or foliage of woody plants, either dead or alive, and but rarely upon soil of any kind. We are assured by M. Decandolle that none of the species, when exposed under water to the influence of the solar rays, give out oxygen, but that several under such circumstances given out hydrogen.

Fungi, or Mushrooms.

This division, like the lichens and hypoxyleæ, differs from every other in the shape, aspect, and peculiar nature of the species which compose it. Impressed with this variance, the Botanists of former days imagined that mushrooms were the spontaneous offspring of fermentation and putrefaction. They admitted without scruple the doctrine, that organized existences might be produced by apposition of particles of matter

(moleculæ), just in the manner of unorganized bodies; a doctrine which could only be broached during a total ignorance of the fundamental principles of animal and vegetable physiology. This doctrine was applied by Bocconi, not only to fungi, but to many of the aquatic plants; nor was it absolutely rejected by two among our most eminent naturalists, Tournefort and Dillenius. But Clusius, though before their time, had taken a sounder view of the process of nature in the propagation of these organized existences: he was convinced of their reproduction through the means of seed, like all other vegetables. His opinion received support from Micheli and Réaumur; the first discovering the seminula of the BYSSUS *velutinus*, the ECTOSPERMA *terrestris* of Vaucher; the other those of the common Nostoc. The period came when it was no longer permitted to the enlightened naturalist to allow of the possibility of equivocal or fortuitous generations, in face of species established by the analogy and agreement of individual existences, endowed in their races with a constant mutual resemblance. This great task has been accomplished by the botanists of the present day, with a perseverance that reflects honour on their success.

Fungi in general are of a very soft consistence; they grow either upon the ground, or under the ground, or in water, upon either living or dead vegetables, and numerous other substances of various natures. Almost all affect shade and moisture. They are extremely diversified in colour, but none are of an herbaceous green. No oxygen is given out by them under water: some transpire hydrogen gas, others acid carbonic gas; most of them dissolve easily, and undergo putrid fermentation. Chemistry has obtained several azotized products from them, such as albumine, osmazone, adipocire, a fatty matter, and a peculiar substance termed fungine by M. Braconnot. Some contain a kind of sugar, capable of crystallization.

The forms of the mushrooms are extremely various, representing globes, clubs, mitres, hats, bowls, branches of coral, powder-puffs, manes, carding instruments, strips of

parchment, the scum that rises upon standing water, &c. &c.; many are furnished with radical fibres, others have none at all.

The conceptacle or *peridium* often constitutes the entire plant; it opens in various ways, and contains the seminula, either in an unconfined state, or else shut up in elytræ.

The receptacle or nidus of the elytræ or seminula is frequently either a small net *(reticulus)*, or simple capillary filaments *(capillitia)*.

The plant is sometimes enclosed in a *volva*, a thick membrane that comes from its base, and resembles a bag.

The peridium in many of the species appears under the form of a coif or a hat, and is then called *pileus*: this is generally supported on a pedicle.

Before the plant is completely grown up the *pileus* is united to the pedicle by a membrane. When this membrane breaks from the pedicle, and the fragments remain on the border of the *pileus*, it is then called the curtain (*cortina*); but if it breaks from the *pileus*, and remains attached to the pedicle, it is termed the ring *(annulus)*; a *cortina* and an *annulus* may be present at one time in the same individual plant. The *pileus* is commonly furnished at the under side with gills *(lamellæ)*, radiating from a common centre; or with tubes (*tubi*), or with pores (*pori*), or with prickle-like points (*aculei*), all which are the placentæ or receptacles of the seminula.

We have already said that the *peridium* often constitutes the whole plant; an example of this is the truffle, a thick fleshy irregular shaped lump, resembling a tuberous root, multiplied by its seminula being set free by the dissolution of the whole substance. In *Uredo* we find a structure of even greater simplicity than this, one where we can detect nothing by which the idea of a *peridium* or *seminulum* can be suggested; its species consist of little membranous transparent yellowish vesicles originating beneath the epidermis of the leaves and branches of certain vegetables, and emerging through the rupture of this into day. When viewed by the naked eye they look like the pollen of the common white lilly, but when

seen through the miscroscope, we discover that they contain within themselves smaller ones of their own kind, and that these again are most probably the holders of others quite imperceptible to us. Here we have groups of germs or rather undeveloped individual plants, enclosed one within the other, in a way so like what we see in Volvox, that to judge merely by the conformation and mode of reproduction, we should be tempted to rank under the same generic head, the *Uredo*, which belongs to the vegetable division of creation, and *Volvox*, which ranks in the animal division among the animalculæ, peculiar to infusions.

The genera *Uredo, Oecidium*, and *Puccinia*, are intestinal fungi, and grow no where but within the cellular texture of plants. They represent in the vegetable kingdom, the *Hydatides, Tæniæ, Tetrugulæ, Ascarides*, and other worms which live in the bodies of animals. There is this distinction however between the two, that the intestinal worms never appear outwardly, while the intestinal fungi pierce the epidermis under which they originate, and complete their growth in the open air. The manner in which this sort of mushrooms disseminate themselves is still a problem. There can be no doubt but that their impalpable seminula are introduced under the epidermis from without; but how? here the difficulty lies. Are they introduced with the moisture absorbed by the roots from the earth, carried forwards by the circulation of the sap, and deposited in that part of the texture which is exposed to the light; or do they penetrate directly through the epidermis, by the almost inperceptible pores with which it is so thickly perforated? This seems the most probable opinion. In whatever way we explain this phenomenon, keeping always clear of the theory of fortuitous reproductions, it stands an irrefragable proof of the wonderful divisibility of organized and living matter.

Those Botanists who have believed in the presence of male and female organs in the algæ, lichens, and hypoxylcæ, believe that they are also to be found in mushrooms. The gills and tubes of these plants are sometimes provided with fringed

border; this border is considered by Micheli as the male organ; Hedwig, on the other hand, takes it for the stigma, and makes stamens of certain little succulent threads the bearers of minute grains, which according to him surround the reproductive globules, or to speak in his sense, the pistils, previous to the entire expansion of the plant. Bulliard's opinion is, that in several species, the fecundating fluid is naked, and comes in direct contact with the embryos, and that in others it is held in extremely small membranous vesiculæ.

The foregoing summary may enable you to form some conception, how difficult are the study and knowledge of agamous and cryptogamous vegetation; but difficulties are not to deter you. Nor is the interest which the various phenomena of nature excite in us to be computed by the magnitude of the objects in which they are present. If we desire to have a true view of the vegetable creation, we must observe it in all its phases and modifications, seek and determine, as far as we are able, the limits that comprise it, and apply ourselves to trace out the subtle relations that unite by almost imperceptible shades, those almost impalpable grains, those fine threads, those irregular laminæ, those masses of various and eccentric forms, in which organization can scarcely be discerned, with the gigantic vegetables of the forest which shade and adorn our globe.

ART. III. *On* M. Stromeyer's *new Metal, Cadmium. In a Letter from* J. G. Children, *Esq. to the Editor of the Journal of Science, &c.*

MY DEAR SIR,

MR. HEULAND'S kindness in furnishing me with a portion of cadmium, has enabled me to ascertain its chemical relations more fully than I have hitherto seen them described in any of our Journals; if you think the results of my experiments worth communicating to the public, they are much at your

service; but before I proceed to their detail, I beg to acknowledge the liberality which afforded me the means of obtaining them, by the sacrifice of the only specimen of the new metal in the possession of the donor.

I found the specific gravity of cadmium, compared with distilled water at 60°, to be 8.67, and when hammered, 9.05; in external appearance, hardness and ductility, it resembles tin, and is said to possess the property of giving the crackling noise when bent, hitherto peculiar to that metal. It fuses considerably below a red heat, and is very volatile. Its oxide at that temperature is not volatile. It dissolves with great facility in cold diluted nitric acid, and the solution evaporated to dryness, leaves a deliquescent salt, soluble in alcohol, to the flame of which it does not impart any colour. Neither sulphuric nor hydrochloric acids act readily on cadmium in the metallic state; but they instantly dissolve its oxide. The hydrochlorate evaporated to dryness, attracts moisture; at a heat below redness it is completely volatilized.

A neutral solution of the nitrate gave with

Prussiate of potash, - -	a white precipitate;
Hydrosulphuret of ammonia, -	a fine bright yellow ditto;
Solution of sulphuretted hydrogen,	ditto ditto; when heated, it passes to a crimson, but becomes yellow again on cooling;
Oxalate of ammonia - -	a white precipitate, insoluble in oxalic acid;
Potash and ammonia and their carbonates,	a white precipitate;
Chromate of potash, Succinate and benzoate of ammonia Infusion of galls, - - Sulphate of soda,	no precipitate;

Cadmium is readily precipitated by zinc, from its solution in hydrochloric acid, in the metallic state; but, owing I suppose to the very great and nearly equal solubility of the two metals

in nitric acid, it does not so readily separate it from the latter solvent.

1,1 grain of cadmium was dissolved in diluted nitric acid, the solution evaporated to dryness, and heated till nitrous vapour ceased to be given off, and the heat then raised to a dull red. The oxide obtained, weighed 1.2 grs. A repetition of the process produced neither increase nor diminution in its weight. From this experiment, unless the small quantity of metal on which it was made militate against its probable accuracy, the equivalent number for cadmium is 82.5, taking hydrogen as unity, or 110, on Dr. Wollaston's synoptic scale.

The oxide of cadmium precipitated by ammonia from its solution in an acid, is redissolved by an excess of the alkali: pure potash, on the contrary, does not dissolve the oxide, but throws it down from its solution in ammonia. This furnishes a ready method of separating it from zinc, and of ascertaining its presence, when accompanied by a very large proportion of that metal, (as in Blende) which, it giving an abundant white precipitate with sulphuretted hydrogen, when that test is applied to a mixed solution of the two metals, so envelopes the cadmium, that the peculiar yellow colour of the latter sulphuret is hardly perceptible, and consequently, unless previously freed from the zinc, the cadmium may easily be overlooked, though actually contained in the ore. Dissolve the mineral supposed to contain cadmium, in nitric acid; to the filtered solution add ammonia in excess, to throw down the oxides of iron, and redissolve those of zinc and cadmium; pure hydrate of potash will then separate the latter, which, when redissolved in diluted hydrochloric acid, will afford the characteristic bright yellow precipitate on the addition of sulphuretted hydrogen.

In this way I have found the metal in a brown lamellar blende from Freyberg, for which I was also indebted to the kindness of Mr. Heuland. The preceding results sufficiently distinguish cadmium from every other metal hitherto known.

Thinking it possible it might contain combined arsenic, I endeavoured to ascertain its presence by the delicate test of

nitrate of silver and ammonia, in the manner recommended by Dr. Marcet, but could not discover any trace of that metal.

I am, ever, my dear Sir,

very truly yours,

British Museum,
Nov. 27. 1818.

J. G. CHILDREN.

P. S. I have made an experiment to ascertain the equivalent number for lithium, which agrees pretty nearly with M. Vauquelin's.

17.7 grs. of sulphate of lithia were heated in a glass capsule over a spirit lamp, till the mass began to fuse and get pasty. They were then dissolved in distilled water, and precipitated by nitrate of barytes. The sulphate of barytes, well washed, dried, and ignited, weighed 35.33 grs. equivalent to 12 grs. of sulphuric acid. The sulphate of lithia therefore contained,

lithia	5.7
sulphuric acid	12
	17.7

Peroxide of copper contains $\frac{1}{5}$ of its weight of oxygen, and combines with a quantity of sulphuric acid, equal to its own weight. On the theory of Berzelius, that bases which saturate the same quantity of acid, contain equal quantities of oxygen, 5.7 grs. of lithia must contain the same as 12 grs. of peroxide of copper, or 2.4 grs. and lithia consequently be composed of

	lithium	3.3
	oxygen	2.4
or per cent.	lithium	57.89
	oxygen	42.11
		100.000

On these data, supposing lithia to be a protoxide, the equivalent for lithium is 10.31, and for lithia 17.81: hydrogen being 1; or on the synoptic scale, lithium 13.74; lithia 23.74.

M. Vauquelin's experiment made lithia to be composed of

oxygen	43.5
lithium	56.5
	100.0

which gives 9.74, and 12.98 as the numbers for lithium.

Art. IV. *Description of two Micrometers, designed and used as Pyrometers.*

Being engaged in a course of experiments and observations, which needed very delicate and accurate instruments for the measure of great heat and not being satisfied with any of those hitherto in use, I have endeavoured to devise means of determining, in a more simple and effectual manner, the changes of temperature undergone by bodies urged to a strong heat. Having accordingly, some time since, provided myself with instruments adapted to my views, and at the same time susceptible, as I am willing to believe, of different useful applications, I submit a descriptive explanation of two of them, in the hope that their construction, or the principle of it, may be found not unserviceable, apart from the researches and experiments with a view to which the instruments have been constructed, and in the progress of which they are employed.

The primary object, as already mentioned, was to devise means of measuring variations of high temperature. For this purpose the expansion or contraction of solid or fluid substances have been considered to present the best or most promising resource. Instruments adapted to render manifest the dilatation of a fluid, for this end, have from the earliest invention of them, received the name of thermometer or thermoscope, (the latter term is nearly obsolete.) An instrument rendering sensible the expansion of a solid, was called by its inventor * a pyrometer; and the term has continued to retain

* Musschenbroek. Comment. Tentam. Fiorent. 2. 12. See Desaguillers, Exp. Phil. i. 421.

this distinctive acceptation; and it has been accordingly applied to an instrument indicating increments of heat by contraction of the substance, although this was denominated by the inventor himself,† a thermometer.

The expansion of fluids, whether liquid or gaseous, under uniform or ascertainable pressure, or the absence of it, is easily made sensible, and is readily submitted to inspection, without aid of magnifiers, by the plain expedient of connecting a narrow tube with a proportionably large reservoir. It has been found to furnish an excellent and most satisfactory method of measuring any moderate temperature, and the variation of it. Difficulty has been, however, experienced, in extending the range of thermometers, constructed upon the principle of determining the actual or potential expansion of a fluid, liquid or gaseous. The obstacles, which are here encountered, are not perhaps insurmountable. A ductile solid, which is by heat converted into a viscid liquid, may be confined in such a manner, as to restrain the dilatation of it in two of its dimensions, and force the increase of bulk into the direction of the third dimension, which is by suitable means subjected to examination. But not to pursue these views further at present, it is in the first instance proposed to describe certain instruments contrived to measure heat by expansion of solids. Such bodies are more easily and conveniently managed, than gaseous or liquid fluids, when subjected to examination under great and violent changes of temperature.

But the alteration of magnitude being small for very great differences of heat, it is not competently measured, unless the minutest change of bulk or of one dimension of it can be rendered manifest. The modification of the bulk or mass is indeed susceptible of exact measurement at a moderate temperature, by the difference in the quantity of the liquid displaced by the body under examination in its dilated or undilated state; or by the change of its gravity in a uniform resistent medium, determined by weighing it in both conditions; but not so readily, nor by methods equally obvious, when the temperature is very greatly raised, and precludes immersion of the

† Wedgwood, Phil. Trans. lxxii. 305, and lxxiv. 358, and lxxvi. 390.

body in a fluid. The question therefore, of devising a way of employing a solid body as a pyrometer, appears, in this view of the subject, to be identified with that of contriving a convenient micrometer, properly adapted to the main purpose of detecting and rendering apparent any very minute increase or diminution of the dimensions of a body submitted to examination, whether as the direct object of experiment, or as a test and standard of observation.

It had long ago occurred to me, that a combination of proportional compasses, or which is in effect the same thing, a train of levers, might be applied to measure very minute angles, and consequently any very small object, by magnifying a small acute angle into a large obtuse one. The idea is not altogether new; nor is even the application of the principle to the special purpose of a pyrometer, novel. It was in one form proposed by Dr. Cromwell Mortimer,* and in another by Mr. James Fergusson;† but, in both instances, without mention of certain requisite corrections, which will be here subsequently noticed. It evidently constitutes a more handy and convenient instrument than a single lever, with vast disproportion between its arms (though this also would serve to magnify a small arch into one more discernible;) because in the single lever, the augmentation of power or space described, increases in the arithmetic progression with its increased length; but in the combination of levers, the described space grows in the geometric progression; that is, it answers to the series of the powers of the ratio between the unequal arms of the levers (supposing all similar;) or is as the product of the large arms to the product of the short ones (whether the levers be alike or unlike.) Thus two levers with arms in decuple proportion, multiply a hundred fold; and three, a thousand times.

An objection to the direct application of the train of levers to the purpose of a pyrometer is, that in this, as in most other instruments which have been proposed at various times for the same end, the heated object, coming in contact with it, affects the temperature of the instrument itself, and consequently

* Philos. Trans. 1747, No. 484.

† Lect. on Select Subjects, 16.

tends to induce error. In constructing an accurate instrument, this objection then is to be studiously obviated; and that may be accomplished by applying an apparatus not directly to the object which is to be measured, but mediately presenting it to an intervening object, the dimensions of which nowise affect the result of the measurement.

A transverse rod, as thin as may be consistent with its rigidity, will answer this purpose; being placed rectangularly to the linear dimension which is the subject of measurement. For, as the expansion of it is longitudinal, (that of the thickness being inconsiderable, and its operation avoided;) it induces no error: and precluding the mutual contact of the micrometer and object, it prevents the communication of heat between them, and any consequent disorder of the apparatus from this cause.

Pursuing these reflexions, it was readily perceived, that by calling in the aid of trigonometry, the minute linear quantity to be examined, and the instrument brought to its examination, may be placed in such relative situations, as that a quantity of a distinctly discernible magnitude should be exhibited to the view, and a very minute quantity be concluded from the observation, by the help of trigonometric tables ready calculated. Versed sines, and the excess of secants above radius, are at the outset very minute in comparison with the correspondent arc, its sine and tangent: and seem, for this reason, entitled to be preferred.

In Mortimer's,* and Guyton Morveau's,† and other analogous constructions, the linear quantity to be measured is either the chord or sine of the angle, and in small arcs, nearly equal to the arc itself. It is only by greatly magnifying the arch that the minute quantity can in this manner be made the subject of observation.

But on the construction here chosen, the fulcrum of a lever being placed in a fixed position, its arm (or the arms of two levers, as in proportional compasses,) turning on a pivot, may be taken for a constant quantity and represent radius: the

* Phil. Trans. 1747, above cited.

† Ann. de Chimie, xlvi. 276.

portion of the transverse rod intercepted between the two points of the levers is a chord; and the quantity to be measured is the versed sine answering to that chord, and to the sine of the semiarc, and is the complement of the cosine of that semiarc.

Since the versed sine is, in the case of very small arcs, minutely little in relation to the radius, and even to the arc: (it is no more than the $\frac{432}{10000000000}$ part of the radius for an arc of, one minute, and only the $\frac{1523}{10000000}$ part, for an arc of one degree:) and since the arch, or its correspondent angle, may be itself magnified if requisite, by combining a micrometer of the other construction with this, means are amply possessed for measuring with precision a very minute quantity in any or all of its dimensions; and with a degree of accuracy corresponding to the correctness with which the length of the levers and their arms has been determined and adjusted.

The accompanying delineation of both instruments (*see the Plate*) will serve to remove the obscurity of the foregoing explanation, and of the further elucidation of the principles on which they are framed.

The arrangement of combined levers consists in a series placed in a straight line, as in Musschenbroek's combination of three levers;* but so that the tip of the one is short of the fulcrum of the following one, (by an aliquot part of its length) and they are put alternately in such a manner, that a lever being made to diverge from the common line, pushes aside the next succeeding one. It is apparent, that the long arm of one lever, pressing upon the short arm of the other, makes it diverge to a greater angle; and the sine of the one angle, for which the long arm of the lever (a constant quantity) is radius, is equal to the tangent of the other angle, for which the original short arm, or distance between the fulcrum and the tip of the preceding lever (also a constant quantity) is radius. The actual short arm is secant of the same angle.

By computing back from the obtuse angle observed, to the original acute angle, which was too minute to be distinctly

---

* Elem. § 333. Introd. § 492.

seen, this is found; and from it the minuter quantity which was to be measured; and all this with great facility by trigonometrical tables. The constant quantities, or arms of the levers, should be in a decuple proportion, to render the operation completely facile: and further to abridge labour, tables have been computed, and will be communicated, should the use of the instrument be adopted by any besides its author.

It may perhaps be asked, what advantage is ascribed to this construction above a train of wheels, by which the same effect of exhibiting a multiple of the magnitude presented to it might be equally produced? The reply is, that friction is obviated; which is a most essential point, and not attained by any train of wheels furnished with teeth, leaves, or cogs, or with inequalities serving as such.

This is a prominent and material difference between the construction now proposed, and that which was suggested for the same use by Mortimer; and with a different design by Musschenbroek. They place and retain the combined levers in contact throughout the performance of the instrument; and friction, which tends to vitiate the results, is not avoided in any mode of employment to which either of their instruments is adapted.

The present construction, as before intimated, differs from Mortimer's combination of two levers of the first kind, and from Fergusson's combination of two of the second, in another essential particular. Both these writers appear to have overlooked the material circumstance, that the short arm of their levers is not a constant quantity: and the latter has not observed, that, in his construction, the length of both the arms is variable. The variation is indeed not great in a combination of a single pair of levers; but is very considerable in a larger train: and Mortimer appears to have contemplated such an increased one.

The principle of the other micrometer is, as I take it, altogether new. An instrument might be proposed on a similar principle, as was above hinted, by placing the object to be measured in the situation of the excess of the secant above radius, instead of that of versed sine. But upon consideration

of the comparative advantages of each construction, and after designing both, that which is founded on the position of the object as a versed sine, relatively to the instrument by which the correspondent angle is determined, has appeared preferable, and has been adopted in the execution of the design.

H. T. C.

References to the Figures.

Fig. 1. A. B. Legs of compasses turning on the pivot P.

E. Object of which the varying magnitude is to be measured.

C. D. Transverse rod, with which the legs of the compasses are in contact.

E′. The object dilated.

C′. D′. The points of the transverse rod, with which the tips of the compasses altered in position come in contact.

A′. B″. The legs of the compasses in their altered position.

Obs.—The angles are measured both on a graduated arch, and by chords marked on the transverse rod.

The difference between the versed sines of the angles is the quantity sought.

Fig. 2. A. B. C. D. E. Train of levers or needles traversing on the pivots P. P.

F. G. Common line of the levers or needles.

E. Position of a needle when unemployed.

A. B. C. Position of needles measuring a magnitude by augmenting the acute angle of the first to the obtuse arc of the third.

Obs.—The distance between the pivots exceeds the length of the needle's arm by an aliquot part.

Art. V. *An Hypothesis to account for the variable Depth of the Ocean.*

Among the numerous theories, conjectures and hypotheses, which have been proposed, to account for appearances

indicating the former submersion of rocks now found in elevated situations, the following is not recollected to have been yet suggested. It is therefore, with great deference, submitted to the consideration of those whose attention has been engaged by such subjects.

It is to be premised by way of postulate, that the earth's mass has been at some antecedent period liable to change of mean temperature; and that the heat of the entire mass, not sensibly affected by minuter variations of seasons, has at some time, however remote, been greater, be it but in a small degree, than it is in the present condition of the globe.

Evidence and argument are not wanting to shew the truth of these postulates respectively. If the earth's heat be wholly derived from external impressions, it must have been subject to alteration, at least during a period requisite to its attainment of that degree of heat which is now become permanent. However short that period, compared with the earth's duration, it could not but suffice for producing sensible effects on the mass exposed to change. If the earth's temperature have been partly derived from internal causes, whether their operation be supposed to have ceased or to have merely declined in energy, the inference is in either case inevitable, that the mean temperature of the mass has not been uniform from the beginning of time.

Our knowledge of the earth's mass is so superficial, that we have little means of judging of its composition. But, if a great portion of the aggregate, as is presumable, have been subject to alteration of structure, as the surface unquestionably indicates, the change can scarcely have happened without transient variation of the temperature. If much chemical action took place in any age of the world; if a large portion of matter passed quickly from a liquid to a solid state, or was fused and afterwards consolidated; if a gaseous fluid became liquid, or if a liquid substance became fixed; the change must have been attended with extrication of heat, according to laws of nature which observations have made known to us. And, according to those laws, the diffusion of

the heat thus suddenly let loose would not be confined to the contiguous portions of the earth's substance. The globe appears both to receive and to send forth impressions of heat. Its communication of temperature is not limited to portions of its own mass, but extends to surrounding space, and to other bodies. It receives heat from the sun: it gives out heat around; to the moon perhaps. If the progress of change, then, have proceeded in any age of the world with more activity of the cause, and greater promptitude and quantity of effect, than at another time, the same equilibrium of impressions taken and given could not exist, exhibiting a strictly equable temperature. The earth must have been hotter, as it must have been colder at times, than the mean warmth in the medium of ages.

Let this be conceded, and we may proceed to consider the effects, which would necessarily attend the imagined change of temperature; upon the supposition, that the chief bulk of the earth, like the shell of it, with which alone we are distinctly acquainted, is not homogeneous. Upon this supposition, the unequal expansion of heterogeneous substances would necessarily produce a solution of continuity; even granting that the nucleus did at some period possess unbroken solidity, and a texture impenetrable to fluids. It follows, as a necessary inference from the concession, that the earth's nucleus, even if previously impermeable, was no longer so, when the unequal dilatation of the component substances had produced fissures. There is ground then to conceive the earth as an aggregate of solid matter not devoid of interstices, and consequently permeable to liquids.

The inference could be avoided only, by assuming that the earth's nucleus is a perfectly non elastic solid. But no such substance immutable, unexpansive, and incompressible, is known. Neither is there ground to presume its existence.

The earth then may be conceived as a solid globe pervaded by liquid matter, or as a fluid one with solid bodies intermixed. Each of these mutually penetrating spheres, or rather spheroids, compress their own component portions. Water, liquid at the earth's mean temperature, must assume the spheroidal

arrangement with dimensions of that spheroid enlarged by the interposition of solid bodies among its particles, yet determined by gravitation to a hydrostatic equilibrium. The globular heap of solid bodies heavier than water, must be similarly considered as composed of definite bodies, resting one upon another, compressed by mutual gravitation into a compact mass, not however devoid of interstices scattered through the substance.

Now let a subsequent alteration of temperature be conceived to take place: whether, after disturbance, returning to the mean degree of heat; or, in consequence of it, deviating from that mean; it will follow, that the dimensions of the earth must undergo a change; and as the expansion and contraction of solids and fluids differ, the relative dimensions of the liquid and solid spheres will be diversified. If the temperature have risen, the solid earth is enlarged, in the proportion say of a five-thousandth part of its bulk for a given degree of the thermometric scale. But as liquids are dilated more than solids, when heated to a given temperature, the liquid watery mass, which occupies the interstices of the solid globe, will be still more augmented: suppose a thousandth, or two-thousandth, or even a four-thousandth part of the bulk. The liquid, as is evident, must stand at a higher level than it before did, with relation to the solid. On the other hand, let a diminution of temperature be imagined: The fluid now contracts more than the solid; and consequently the watery sphere is reduced to less dimensions in proportion; and its surface must sink therefore to a lower level with relation to the solid whose interstices it fills. It was higher relatively to the irregular surface of the globe; it is now depressed, and stands lower with reference to the same surface. The superficial terminations of the solid emerge with any reduction of temperature; or are submerged by increase of heat.

It is then clear, that the hypothesis of a change of the earth's temperature would suffice to account for the rise of a watery ocean above a lofty point of the solid surface; and for its receding thence with the diminution of the general temperature. It is however to be enquired what degree of change

is to be therefore surmised; whether a small difference be adequate to the explanation of the phænomena; or whether the extravagant supposition of great change would be requisite.

Now, supposing the mean temperature of the whole mass to be not very different from the mean of the entire surface, subject to observation, it may be taken as stationary at or near 67° of Fahrenheit's scale. The expansion of water near that point of the scale is about 0 00011 for a degree. The correspondent linear expansion is .000037. The linear expansion of the most dilatable of solids that have been accurately observed, is .000016; but of others much less; as glass and platina; viz. .0000045, and .00000475. That of some substances not yet accurately observed, would appear to be still less considerable; and of this class are crystalline stones and earths. Assuming the mean dilatation of the globe's fixed substance to be nearly that of vitrified matter, which is however greater than the medium of the commonest natural bodies with which we are acquainted, as quartz, felspar, hornblende, trap-rocks, &c. the difference of expansion is no less than .0000325 for a degree of the thermometer.

That is, in round numbers, and in general terms, the expansion of the liquid exceeds that of the solid, by a ten-thousandth part of the bulk; or by a thirty-thousandth part of the lineal dimensions; and an increase of one degree in the temperature of the whole does consequently elevate the surface of the liquid sphere so much as a hundred, or say a hundred and twenty fathoms, more than that of the solid sphere, which it interpenetrates.

Variableness of temperature within a limit of very few degrees, will suffice then to account for great variation of the level of the ocean; as great as the flat strata and tertiary rocks of the earth's shell seem to manifest; perhaps as much as the secondary or transition rocks exhibit.

Precision in this matter is unattainable; and the affectation of a semblance of it has been here purposely avoided. Yet a rather nearer approach might be made, were we in possession of observations for the expansion of the commonist

substances, namely, stones of every sort. With a view to other and more useful purposes than the present speculation, it would be desirable to possess such observations; and researches relative to this object have been accordingly instituted, and are in progress. But the expansion of the solid is so inconsiderable in comparison with that of the liquid substance, that the general conclusion, as it has been given in gross numbers, will be little affected by their result.

Yet the hypothesis which has been proposed, may receive countenance with accession of probability, from an accurate determination of the expansibility of that class of bodies, which would appear to be most abundant, and may be presumed to enter most largely into the composition of the globe. As already acknowledged, our superficial acquaintance with the earth's shell, is not a ground of confident inference as to its internal structure. It is however to be remarked, that the earth's mean density, as deduced from observation and experiment, does demonstrate, that it cannot be chiefly composed of the more ponderous metallic bodies, which have a greater specific gravity even at the sphere's surface; nor of ductile substances of any kind, the density of which would be greatly increased in a profoundly interior situation; nor even of water; for this cannot be the predominant ingredient in the composition of the globe, though in all likelihood universally diffused throughout its substance, since the density of inferior laminæ so much increases with the weight of the superincumbent layers, that a sphere chiefly or exclusively formed of water would exceed the ascertained density of the earth, though this be five and a half times as great as that of water at the globe's surface.

The presumption then is, that the globe is principally composed of substances that have little elasticity; that are not compressible into density and compactness much exceeding, more than doubling or tripling, for example, upon a medium of the whole, the density exhibited at the surface. Such substances are as little dilatable, as they are sparingly compressible; and, among known subjects, that character assuredly belongs to the crystalline components of the primary rocks.

But whether the interior of the globe mainly consist of such substances, or of other solid matter, no specimen of which is manifested at the surface, or near it, within reach of man's research, it is on either supposition shown, that the solid substance of the globe, being matter little compressible, is likewise as little expansive; and that the liquid matter, diffused through it, is much more dilatable. This position, independently of any surmise or presumptive evidence of the specific substances prevalent in the earth's composition, suffices to uphold the theory proposed to be established on the assumed basis of a change of mean temperature.

Upon the same grounds it may be received as a fair deduction from the premises, that no appreciable variation of the mean temperature has taken place in recent ages; since the level of the ocean appears to have been of late unchanged. Or, if it be admitted on the evidence adduced by divers writers, though not generally deemed satisfactory, that the level of the ocean does appear to be in progress of depression; then the hypothesis, which is the subject of this paper, is offered as an explanation of that appearance; and the earth, it may be said, is slowly cooling, as the sea is receding from its shores.

November, 1818. H. T. C.

Art. VI. *On Nitric Acid.* *By* Andrew Ure, *M.D. M.G.S., &c.*

In the Journal of Science and the Arts, for January last, I had the honour of submitting to the chemical world a Memoir on the Constitution of Liquid Nitric Acid, including two Tables, constructed with much attention, and founded on experiments very carefully conducted. Having no powerful patron to flatter, nor morbid bile to discharge, I endeavoured to express myself in the most dispassionate language.

The Journal for April contains "Remarks on Dr. Ure's paper on Nitric Acid," in a communication from Mr. Richard

Phillips, distinguished for insolence which no pride of rank or of genius could excuse, joined to ignorance of chemical principles and practice. A feeling of contempt has hitherto withheld me from recurring to the subject of his paper, till lately, having had occasion to examine a few of the nitrates, two or three interesting facts occurred, which I now beg leave to present to the public. I shall first, however, bestow a few salutary animadversions on Mr. Phillips, and then detail my new experimental researches, which I hope will amply confirm the truth of my published tables.

My introductory statements in the January number, relative to the composition of *dry* nitric acid, were taken from the last edition of Dr. Henry's Elements of Chemistry, and for the discrepancies on the subject thence copied by me, that able chemist can easily answer. Of M. G. Lussac's candour, as well as attainments, who ever expressed a doubt? I am happy to find that his lately corrected results, coincide so nearly with the determination of an equally eminent English philosopher, Dr. Wollaston. My object was avowedly the constitution of *liquid* nitric acid.

Mr. Phillips displays in the following paragraph of his Remarks, an incredible ignorance or perversion of chemical science.

" *It is scarcely necessary to observe, that the number representing a compound body cannot be ascertained, without a previous knowledge of the proportions of its constituents:* and it must be allowed, that Dr. Ure would not represent nitric acid by a number which he knew to be inaccurate; but having denied the accuracy of every previous analysis, we are at liberty to conjecture that 67.5, as above quoted, result from the performance of those experiments before the close of his paper, which he appears only to have contemplated at its commencement. But supposing this to be the case, it is very remarkable that Dr. Ure should not have allowed that 67.5 is almost precisely the number, by which nitric acid is represented on Dr. Wollaston's scale, for he is acquainted with this instrument, and even quotes it on another occasion, to prove its

inaccuracy; in the present instance, therefore, it would have been but candid to have excepted Dr. Wollaston from those whose efforts have been 'baffled.'"*

The malignant insinuations dispersed through this *candid* paragraph, and the one immediately preceding it, are too despicable for notice. The commencement, which I have put in italics, contains unquestionably the most daring falsification of chemical philosophy and chemical practice, ever obtruded on the public. We may justly parody the passage, and say, "It is scarcely necessary to observe," that Mr. Phillips betrays entire ignorance of the first rudiments and plainest principles of a science, in which he arrogantly usurps the office of Censor General, and Dictator. "*The number representing a compound body cannot be ascertained without a previous knowledge of the proportions of its constituents!!!*" Had he said CAN, instead of CANNOT, he would then have spoken truth. Why he has so grossly violated it, we need not inquire. How did Dr. Wollaston determine, for his admirable scale, the numbers representing the *compound* bodies, barytes, lime, strontites, magnesia? Was it from the proportions of their constituents? No truly, but from far surer *data;* from the proportions in which these compound bodies saturate any other one whose equivalent is well ascertained; such as carbonic or sulphuric acid. And in the very same way, the number representing any compound body, susceptible of definite combination, CAN be ascertained *without* any previous knowledge whatever of the proportions of its constituents. I appeal to every chemical philosopher in Europe for the justness of this proposition. Indeed, to determine the number representing any compound body, from the proportions of its constituents, so far from being, as Mr. P. asserts, the sole method, is very rarely to be placed in competition for exactness with the other method, which is absolutely

* Remarks on Dr. Ure's paper on Nitric Acid. By Richard Phillips, Esq. Journal of Science and the Arts, No. IX. pages 164, 165.

independent of our knowledge of the constituents. Of this truth, we have striking examples in the vegetable acids, citric, oxalic, acetic, &c. Their equivalents are most rigidly determined, by the quantity of alkaline or earthy base, which they can respectively saturate; after this is found, we may distribute the proportions of their constituents, hydrogen, carbone, and oxygen, very much according to fancy.

In like manner, and with the same precision, the number representing the compound body nitric acid, CAN be determined, without any reference whatever to its composition, or, in Mr. Phillips' words, without a previous knowledge of the proportions of its constituents. It was on this obvious and well established principle, namely, combination with a base, whose equivalent I had previously ascertained, that I satisfied myself, of 67.5 being very nearly the equivalent for nitric acid. It was gratifying to have the concurring authority of Dr. Wollaston for nearly the same number.

Mr. Phillips refers to Dr. Wollaston's excellent Paper in the Philosophical Transactions for 1814, explanatory of his Logometric Chemical Scale. Now I defy any person of common intelligence, or honesty, to read it, without perceiving that its celebrated author has determined, as I did, not only the number representing this same compound body nitric acid, directly and without dependence on the analytical examination of its constituents; but that he has gone much further, having on the same principle, inferred the proportion of the constituents from the weight or number representing the compound body. The sole *data* employed by him in this research, are derived from the composition of nitrate of potash. He takes Richter's synthesis of nitre, in preference to his own; though all who are conversant in physical science, are aware of his singular precision. His own synthesis of nitre gave him 66.9, for the equivalent of dry nitric acid, and of course 16.9 for that of azote. Richter's results furnish the number 67.45; which Dr. Wollaston converts, for an ingenious reason, into 67.54, being a very trifling change.

" The proportion of nitrate of potash, which I have ob-

tained by evaporating such a solution" (viz. 125.5 bicarbonate potash, saturated with nitric acid) " by a heat just sufficient to fuse the residuum, gave at the lowest in three experiments, 126 for the equivalent of nitrate of potash; from which, if we deduct 59.1 potash, there will remain 66.9, as the apparent equivalent of dry nitric acid. Consequently I have no hesitation in preferring the estimate to be obtained from Richter's analysis of nitrate of potash, which gives 67.45, from which, if we subtract one portion of azote, 17.54, there remain 49.91, so nearly 5 portions of oxygen, that I consider the truth to be 17.54+50, or 67.54."* This number 17.54, had been previously obtained for azote, from the composition of ammonia, by the theory of volumes, and the specific gravities of hydrogen and azote; and 50 of oxygen, are hypothetically inferred by Dr. Wollaston from Richter's analysis of nitre. In my Papers on the Ammoniacal Salts, and on Sulphuric Acid, I have long since recorded my sense of the value of the Logometric scale, in such terms, as amply refute Mr. Phillips's insidious insinuations.

A little further on, Mr. Phillips says of me, " but having denied the correctness of every previous analysis, &c." Now, this is a misstatement of my language. In a short introductory paragraph of eleven and a half lines, I detail from Dr. Henry, the discordant numbers of two eminent modern chemists. But I no where asserted that every previous analysis was incorrect. So far from doing this, it is evident that Mr. Dalton's result agrees nearly with my determination, made by that method, which Dr. Wollaston prefers for its exactness, and which Mr. Phillips ridicules as impossible. Mr. Dalton gives 7.33 per cent of oxygen in dry nitric acid; my number indicates 74. Mr. P. says " it would have been but candid to have excepted Dr. Wollaston from those whose efforts have been baffled." This is a curious remark. Does not Dr. Wollaston, with the candour characteristic of a superior mind,

* Dr. Wollaston's Synoptic Table of Chemical Equivalents, Ph. Tr. for 1814, Part 1st, pages 11, 12.

actually renounce his own result, decline to confide in his own efforts, and follow, in preference, the determination of a German chemist?

But the most ludicrous blunder in Mr. Phillips' paper, and perhaps the most absurd on record, in any book of sober science, is contained in the paragraph which occupies nearly the whole of page 166. It is needless to quote it all. The following sentence is complete in itself, indicating a confusion of intellect, bordering on fatuity: "If however we compare "these numbers" (79.24 and 67.5) "with those which are to "be derived from Dr. Ure's analysis of liquid nitric acid of 1.5, "it will appear that this acid is composed of 67.5 one atom "acid, united to 16.79 water, and consequently of one atom "acid, and one atom $\frac{547}{1132}$ of an atom of water, a conclusion "of which it may be truly stated in the language of Ure, that "it exhibits internal proofs of inconsistency and error."

I can find no words in the English language, adequate to express my astonishment, at this labyrinth of nonsense, in which Mr. Phillips has bewildered himself, and in which he tries to perplex his unwary readers. Who ever dreamed, before Mr. P., that either nitric, or any other liquid acid, would refuse to combine with water, in any proportion however indefinite, that is, with any number of atoms of water, from 1 to a billion? What mystic charm resides in the number 1.5, why nitric acid should, at that density, and no other, consist of 1 atom of dry acid, and 2 of water? The very problem which we seek by experiment to solve, is the proportion of water in acid of 1.5; and since there is no necessary connexion whatever, except in Mr. Phillips' brain, between the specific gravity 1,5, and the above atomic proportions, neither my numbers, nor those of any other person, on this point, can "exhibit internal proofs of inconsistency and error." My experiments tend to prove that about the density 1.485, and not 1.500, liquid nitric acid consists of one atom of dry acid, associated with two atoms of water. Now to a pound of this acid, or of any other atomic combination he pleases, let Mr. Phillips add one drop of water in succession after another, and let him compute at every addition, the

atomic proportions on his novel plan, he will find a pretty opportunity of seeing "inconsistencies and errors" in nature, and of exercising his skill in *vulgar* fractions. Or until his head be purged from the fumes of fermenting gall, he may ruminate on the following table of atomic relationships, exhibited in a somewhat more rational and intelligible shape, than his $\frac{547}{1132}$ of an atom.

Liquid Acid of 1500.	Sp. gravities.	Dry Acid in 100.	Atomical Relationship.	
			Atoms of Acid.	Atoms of Water.
100	1.5000	79.7	100	152
98	1.4960	78.1	100	168
96	1.4910	76.5	100	183
94	1.4850	74.9	100	200
92	1.4790	73.3	100	216
90	1.4730	71.73	100	236
86	1.4600	68.54	100	275
84	1.4530	66.948	100	294
83½ nearly	———	———	100	300
83	1.4500	66.15	100	305
57½	1.3340	46.00	100	700
47	1.2765	37.549	100	1000

Should Mr. Phillips wish to amuse himself in torturing the refractory atoms, he is welcome to reckon the fourth column units, corresponding to a variety of decimated atoms, in the fifth, which he may convert into vulgar fractions at his leisure. Let him be reminded, however, that this fraction of an atom, is a monster of his own begetting.

In page 166, he says "to examine the subject experiment- "ally as well as theoretically (vide Mr. Phillips' atomic frac- "tions), I prepared some pure nitric acid, which had a spe- "cific gravity of 1.496, so nearly 1.5, that they may be con- "sidered identical in experiment." Excellent critic! your notions of identity are as admirable as your theory. Acid of 1.496 contains, as nearly as possible, 2 per cent more water than acid of 1.5. Yet they are identical, according to Phillips! In my table which he is vilifying, opposite to 1.5, we have 79.7 of dry acid: and opposite to 1.496 only 78.106.

Notwithstanding this glaring difference, in a minute research like the present, he craftily twists his smaller specific gravity, opposite to my larger proportion of dry acid, and then discovers a great error in my table ! ! ! This is but a shallow trick after all, and it will no longer avail our chemical Dennis. By the nitrate of potash experiment, he obtains 76.367 for the percentage of dry acid in that of 1.496 ; while at the same density I have 78.106, being a difference in excess of only 1.739 ; (not 3.343, as he falsely states ;) and Dr. Wollaston's number at 1.496 is (75.—1.5*) = 73.5, a difference in defect of 2.867 from Mr. Phillips. Hence, by this infallible standard, my experimental error is less than Dr. W's, in the ratio of about 17 to 28, or nearly 1 to 2. Surely so inconsiderable an error on my part, (granting Mr. P. to be exact, which he undoubtedly is not,) did not merit such virulence of abuse to be poured on a person who had never injured the Critic in any respect. In the recent researches of the illustrious Berthollet on the composition of Nitric Acid and Nitre, we have deviations from Mr. Phillips to a far greater amount. Berthollet states the composition of that salt to be 49.9 potash + 50.1 dry acid in 100 parts ; and Richter, as adopted by Dr. Wollaston, gives 46.7 potash + 53 3 acid = 100. To be done with Mr. Phillips *for ever.* " It is easier," says he, " for obvious reasons, to obtain " more accurate results of carbonate of lime, than with carbonate " of potash. I shall therefore now state the experiments which " I have made with this substance." Here we have an assumption bold, gratuitous and false. If his reasons be obvious, they are so only to himself; for certainly we have no chemical substance of more uniform composition than subcarbonate of potash, carefully prepared from crystals of tartar; nor any one which is capable of giving more satisfactory results with nitric acid.

I shall now proceed to my own new Experimental Researches ; and I hope to be able to shew that there are sufficient reasons,

* 1.5 is by Dr. W's proportion equivalent to 2 per cent. less of liquid acid of 1.500 in that of 1.496.

of which no good practical chemist need be ignorant, why results of the rigid accuracy, required by the doctrine of equivalents, cannot be obtained by employing carbonate of lime to saturate liquid nitric acid.

To verify the correctness of my tables with regard to both the columns of liquid and dry acid, by the severest test, I took a pure nitric acid, whose density was considerably different from that formerly employed, and such as could readily be procured at any respectable apothecary's shop in London. Its specific gravity at 60° was exactly 1.3833, opposite to which in my table, will be found 53.399 dry acid, and 67 of acid of 1.5000. I diluted it with distilled water, so that one part of it existed in five parts by weight of the mixture. Thus the quantity of acid expended could be most minutely ascertained.

I. *Experiments with Carbonate of Lime.*

One hundred grains of calcareous spar in rhomboidal fragments, were put into a small pear-shaped glass mattrass, with a long narrow neck, closed with a little glass funnel. Over them were slowly poured 745 grains of the dilute nitric acid = 149 of the stronger. After 20 hours, and repeated agitation, no separation of gaseous globules could be perceived; but the liquid being tried with well stained litmus paper, was found to be distinctly acidulous. During 5 days more, it was occasionally agitated. Excess of acid was still perceptible by the above test, which became very manifest on drying the paper with a gentle heat.*

Since perfect neutralization of the acid, is essential to accuracy, in the present research, I next sought to obtain it by employing the calcareous carbonate in powder. Accordingly 80 gr. of finely pulverised spar were subjected in the above apparatus to the action of 760 grains of the dilute acid, = 152 of that of 1.3833. After the lapse of 24 hours, and oc-

---

* I usually place a small drop of distilled water on the paper, contiguous to the point touched by the glass rod dipped into the solution; and comparing the colours of the two spots in the moist and dried states, I get very accurate results.

casional agitation, it was still found to be distinctly acidulous. The glass funnel, with capillary stem, being left loosely in the orifice of the mattrass, the saline solution was agitated, and inspected occasionally, during the space of four weeks, at the end of which time litmus paper was slightly but manifestly reddened by it, 5.2 grains of powdered spar remained, undissolved.

It was now evident, that when nitric acid in the progress of saturation becomes very dilute, the attraction between it and the calcareous base, is inferior to the affinity exercised by the elements of the carbonate, added to the cohesive attraction of the solid particles; affording a fine illustration of the statical doctrines due to the sagacity of Berthollet.

The above solution of nitrate of lime, slightly diluted with distilled water, being transferred into a hydrometric globe, was found to weigh 1089 grains, which was also its specific gravity, water being called 1000. But 122 grains of an ignited nitrate of lime were required to produce with distilled water, the same weight and density of solution as the above. Hence in the above 1089 grains, there must have existed 122 grains of ignited nitrate. Yet by cautious evaporation of these 1089 grains of solution, in a platina capsule, only 119.8 grains of gently ignited nitrate were procured. It may here be observed, that solution of nitrate of lime, in the progress of its evaporation, becomes a pasty mass, strongly retentive of moisture; and which is apt to exfoliate small fragments, on raising the heat of the sand bath, to the temperature requisite for rendering it dry. A subsequent gentle ignition, moreover, separates a portion of its acid; as is evinced by its forming a milky or opalescent solution with water, which darkens the brightened purple of litmus paper. For these three reasons, therefore, imperfect neutralization at first, loss of particles in evaporation to dryness, and of acid by ignition, I consider carbonate of lime to be a substance incapable of giving results, of such absolute precision, with nitric acid, as the doctrine of equivalent ratios requires.

I may further remark, that the mode of determining the

quantity of a dry salt, in any aqueous solution, by *synthesis*, in which we add to a given weight of the particular salt, successive portions of distilled water, till we form a solution having the same density as that whose constitution is unknown, originally practised by Mr. Kirwan, affords when a certain precaution is observed, which I shall presently indicate, unquestionably a more accurate result, than the analytic mode by evaporation to dryness. With the nitrates, which are known to rise partially along with the water of their solutions, at, and even below ebullition, the comparison of the weight and density of the solution made from the neutro-saline components, with those of a solution made from a pure and dry salt and distilled water, ought never to be omitted. In my former paper, on nitric acid, this important verification was attended to, and gave me entire confidence in the results.

In the preceding experiment, 74.8 grains of spar were dissolved by the acid. These contain 42.187 of lime. Now from 122, if we deduct 42.187, the remainder, 79.183, is the quantity of dry acid resulting from the 152 grains of the stronger liquid acid employed.

And 152 : 79. 183 : : 100 : 52.5, very nearly, being less than my tabular number 53.4, by about 9 thousand parts, a difference obviously due to the acidulous excess as indicated by the litmus paper, and to a portion of nitric acid which escapes with the carbonic. When we employ a stronger nitric acid to dissolve calcareous spar, the escape of nitric acid vapour is very conspicuous; and it must lower the estimate of dry acid in the liquid acid, in a greater or smaller degreee.

52 5 divided by 0.67, gives a quotient of 78.36 for the dry acid in 100, of that of 1.5.

II. *Experiments with Subcarbonate of Soda.*

Thirty three grains of dry subcarbonate of soda, prepared by ignition of the crystallized acetate, were exactly neutralized by 300 grains of the above dilute nitric acid, = 60 of that of 1.3833. This saline solution slightly diluted, was found to weigh 1034.6 grains, which number also expresses its

specific gravity, water being 1000.0. But, conceiving this density to be slightly greater than the quantity of salt should produce, as inferred from previous analytic and synthetic experiments, I naturally ascribed this excess to the presence of carbonic acid in the recently prepared cold solution.* It was therefore gently heated, by immersion of the hydrometric globe containing it, in warm water, when a copious evolution of carbonic acid gas took place. On again cooling the solution to 60°, and filling up the vessel with distilled water to the diamond line on the stem, its specific gravity and weight were found to be only 1034.0. But 51.2 grains of pure and dry nitrate of soda, dissolved in distilled water, formed a solution of the same specific gravity and weight. The first neutro-saline solution being slowly evaporated, yielded 51.1 grains of perfectly dry nitrate of soda.†

33 gr. of subcarbonate of soda contain 19.5 of alkaline base; and 51.2 — 19.5 = 31.7 = the quantity of dry nitric acid in 60 grains of that of 1.3833 ∴ 60 : 31 7 : : 100. 52.83 = the dry acid per cent. And 52.83 divided by 0.67, gives a quotient of 78.85, for the dry acid in that of 1,500. But if we take Dr. Wollaston's composition of subcarbonate of soda, which many will naturally prefer to mine, then 33 gr. of the subcarbonate will contain 19.36 of alkaline base; and 51.2 — 19.36 = 31.84 = the dry acid in 60 gr. of the liquid of 1,3833; and 60 : 31.84 : : 100 : 53.666 = the dry acid per cent; a difference from my tabular number 53.399, of only 0.333, and which may be an error, without any serious imputation against my judgment or skill in experiment. Let us turn now to nitrate of potash, where the utmost precision may be obtained.‡

* If the solution stand a few days in a vessel uncorked, or with a loose funnel, the carbonic acid flies off.

† In other evaporations of the same quantity of solution, only 51 gr. were obtained.

‡ The following fact will shew on what slender differences a frivolous critic may dwell. Had only one tenth of a grain more of nitrate of soda been obtained, then the dry acid would have been 53.23.

III. *Experiments with Subcarbonate of Potash.*

50 grains of ignited subcarbonate of potash from tartar, were exactly neutralized in the small mattrass above described, by 362 grains of the dilute nitric acid = 72.4 of the stronger. The saline solution slightly diluted being heated so as merely to expel the carbonic acid, and then cooled to 60°, weighed 1045.25 grains exactly, which was also its specific gravity, water being called 1000 00. But 140 gr. of pure nitre, dissolved in 1860 grains of distilled water, yielded 2000 grains of a solution, whose specific gravity at 60° was exactly 1045.25. And 2000 : 140 : : 1045.25 : 73.1675, being the weight of dry nitre in the first solution, by the synthetic mode of research. Yet by evaporating the above, and similar solutions, I have generally obtained not more than from 72.5 to 73 grains of nitre from 50 grains of subcarbonate.

50 grains of subcarbonate of potash contain, according to Dr. Wollaston, 34.11 of alkaline base, whose equivalent is reckoned 59 1 ; but by my latest determination, 50 gr. contain 34.2 of potash, making the weight of its atom 59.6, oxygen being called 10.

73.1675 — 34.2 = 38 9675 of dry acid, resulting from 72.4 of that of 1.3833 : and 72.4 : 38.9675 : 100 : 53.82 = the dry acid per cent. If we call the equivalent of potash 60, then the dry acid is 53.7, which number divided by 0.67, gives 80, for the initial or fundamental number of my tables opposite to acid of 1.5, instead of 79 7, as originally stated. The above experiment gives 67.57 for the equivalent of nitric acid, potash being called 59.1 The composition of nitre, by my estimate of the subcarbonate, comes out from the above experiment, 46,74 potash + 53.26 acid = 100. Richter's, which Dr. Wollaston espoused in the construction of his scale, is 46.7 potash + 53.3 acid = 100.

If we adopt Dr. Wollaston's estimate of the subcarbonate of potash, then the above experiment furnishes the numbers 46.62 + 53 38. But when the atom of potash is called 60 the composition nitre will be 46.84 base + 53.16 acid. I give the preference to my own number.

The above experiment is selected from among a great many others of the same kind. I believe it to have been conducted with unexceptionable care, and to be, in its nature, susceptible of the utmost precision. It may be regarded a true *experimentum crucis* in this discussion. It has moreover this great advantage; it may be verified easily by any person possessed of an accurate balance. The mean of the potash and soda experiments is 53.44, agreeing perfectly with my published tables. May I now, therefore, presume to offer my tables of nitric acid,* as well as those of sulphuric and muriatic, to the philosophical and practical Chemist, as not unworthy of his confidence? They contain no doubt imperfections, but such, I trust, as are of no consequence in ordinary practice. They were the fruits of many days, I may say months, minute research, in the Laboratory and the Closet. I shall wait in patient tranquillity, for the award of enlightened and dispassionate criticism.

Art. VII. *On the Acetometer. By* John *and* Philip Taylor.

The uses of acetic acid have been considerably enlarged in this country within a few years by the introduction of some important articles of manufacture, and by the more extended application of some of its compounds to the arts of dyeing and calico printing. Of the former, it may be sufficient to notice the introduction into this country of the manufacture of a very important article of commerce, sugar of lead, which was most successfully done some time since by Charles Macintosh, Esq. of Glasgow, and which has been followed by

* My interpolating series for nitric acid, could have been rendered more minutely accurate, by the introduction of another term; but the errors compatible with the present very simple series, are inconsiderable, never amounting, I believe, to half a per cent. The experimental points given in Table I., I conceive to be very exact.

a general adoption in many parts of the United Kingdom, so as to supply not only the home, but the export trade, with a substance of extensive demand, heretofore only produced in Holland. This has been followed by a manufacture hitherto peculiar to the French, and for which they were supposed to possess superior facilities—that of verdigris, which is now made in England, so similar in quality to the foreign article, as to leave little room for improvements.

These new uses for acetic acid, together with the increasing demands of the calico printer, to whom the acetate of alumine as a mordant, and the acetate of iron as the base of many colours are essential, was likely to produce exertions to obtain the acid in the most economical manner. Some of these purposes required it but of very impure quality, and the acid obtained by the distillation of wood, was readily applied to them without much care or expense in its preparation, and in this state was found to be sufficiently cheap.

The manufacturer of sugar of lead, white lead, and verdigris, by the use of pyroligneous acid, however, required a degree of purification from the tar and peculiar oil with which it is charged in its crude state, that exercised the ingenuity of many of the most skilful manufacturing chemists of this and other countries; and though in England the attempts seem to have been for a considerable time for the most part limited to that degree which its use in manufacture required, yet in France it became an object, which was in great measure attained, to produce it in so pure a state as to fit it for the uses of the table.

In England and in Scotland the same attempt was induced two or three years ago, by the failure in demand of the articles which had given rise to several important establishments, and vinegars prepared from the pyroligneous acid began to find their way into the market, of various shades of purity, and of very different degrees of strength.

Vinegar produced by fermentation, is naturally limited as to the concentration of its acid; and the convenience of commerce has intro :ed considerable uniformity in this respect.

In the purified acid from wood, however, no such limit exists, and as the process by which it is freed from the substances with which it is originally mixed, require that it be first combined with some base, and subsequently separated again by decomposing the compound, it is evident that it may be produced in a great variety of degrees of concentration.

In the application of acetic acid to the purposes of manufacture or the arts, a ready and practicable mode of measuring its strength soon became a very desirable object, and those who employed it had recourse to different means, principally grounded either on its saturation by alkalies, or on the solvent power exerted on some proper substance. As these produced varying results from the unequal skill of the operator, from the difference in the saturating substances, and from the time and circumstances required for the processes, no common standard was to be found, and considerable difficulties occurred in adjusting the question of strength, when acetic acid was passed from one hand to another in the ordinary transactions of business.

We had, in common with other manufacturers, often felt this inconvenience, and being then concerned in an establishment where pyroligneous acid was largely produced and applied, had given considerable attention to the best modes of measuring its strength in various degrees of purity.

When it came into use in competition with common vinegar, the revenue laws which regulate the duty on this article, were found defective, inasmuch as they considered it of uniform quality, and attached an equal duty to a given measure, without providing for a difference in strength, which, in some cases, went so far as to exhibit a pure acetic acid of eight times the power of common vinegar. The law was therefore judiciously altered, and the attention of chemists was directed to the subject.

Among others, we were called upon to contribute whatever our experience might furnish, to render the mode of ascertaining strengths certain and easy of execution to an unpractised operator.

We assumed, as a very desirable object for this purpose, that it should be accomplished in some manner that might be similar to those in use among revenue officers, and by some instrument which might be easy to understand and use; and we directed our attention to finding some plan by which the real quantity of acid might be readily and accurately determined, by instruments similar to those which are used for trying spirits, &c.

The difference of specific gravity in acetic acids of various strengths, when pure, is however too small to afford any correct indication, and is also embarassed by the different proportions of mucilage or saccharine matter in those produced by fermentation. The strength of vinegar in different states of concentration cannot be determined with the same facility, or by the same means as are employed for spirit or the mineral acids; the specific gravities of these latter substances diminish or increase in the ratio of their strengths, by quantities sufficiently great to allow of the formation of an accurate hydrometer for their measurement. This, however, is not the case with acetic acid, the total amount of difference in gravity between the strongest and the weakest being comparatively small, at the same time that many circumstances tend to render this a fallacious guide.

Common vinegar, for instance, indicates a specific gravity of 1025, of which a certain proportion is owing to mucilage, &c.; as pure acetic acid of equivalent strength gives only a specific gravity of 1008.5, and pure acetic acid 13 times as strong has only a gravity of 1072. Comparing these with the gravities of sulphuric acid of equal saturating power as common vinegar, and of an acetic acid 13 times as strong, we shall find the difference to be as 1033 is to 1660 = 627 instead of

$$1008.5 - 1072 = 43.5.$$

and as vinegar is often a mixed fluid, containing mucilage, extractive matter and spirit, it may indicate a high gravity without being strong, or it may have considerable strength without being heavy.

We proposed therefore to construct an instrument to measure *an acquired specific gravity*, and which should be uniformly as

the strength of the acid. For this purpose, it was necessary to furnish a substance for previous combination, which should unite with the acid rapidly to complete saturation, and of which the addition in excess should produce no inconvenience. We knew that hydrate of lime possessed these qualities, and that it was well qualified for the purpose, by the uniform state in which, with sufficient care, it may at all times be prepared and kept. It was only necessary to determine by careful experiments, the relative increments in gravity acquired by the saturation of acetic acid, of known strength, by this substance, and to accommodate to them an instrument of easy application.

We proceeded to these experiments with the assistance of our friend, Mr. Richard Phillips, whose accuracy and skill in chemical research are so well known.

There is one advantage in the use of hydrate of lime for the purpose, which may be mentioned here, which is, that as it constantly precipitates in the saturation a considerable portion of the mucilage, it serves partly to get rid of that difficulty, and to render the compensation which is to be made for that mixture more uniform than it could be in an uncombined acid.

A standard strength of acetic acid was the first thing to be determined, which it was desirable should be such as was usually found in the best common vinegars made by fermentation, or such as paid the previous duty, which it was not intended to increase.

The best vinegar of this kind is called by the makers No. 24, and a variety of experiments had been made upon it by Dr. Thomson, who had found it to contain, at a mean, about 5 per cent. of real acid.

We found by several trials, that different samples of the best vinegars had some variation in this respect; but after many, and we believe, accurate experiments upon them, we thought the proportion assigned by this distinguished chemist to be a fair and proper one, and we assumed it as the standard of vinegar strength, or, as it has since been denominated, that of proof acid.

We then proceeded to ascertain its power, by saturating an alkali, selecting for this purpose one which might be referred to at all times with the best chance of being always obtained in an uniform state, and taking therefore well crystallized subcarbonate of soda.

The proof acid containing 5 per cent. of real acid, was found to require 14.5 parts of subcarbonate of soda to each 100 parts of acid, for complete saturation.

These experiments were checked by corresponding ones on oil of vitriol, which has a nearly equivalent power to that of real acetic acid.

The next step was to prepare a series of pure acetic acids, of which the strengths should bear a regular proportion to that of proof acid. We prepared for this, by making a quantity of acetic acid at the highest practicable degree of concentration.

For this purpose, we made acetate of soda, by decomposing pyrolignite of lime by sulphate of soda, and very carefully purified the product by repeated solution and crystallization. The salt thus obtained in a perfectly white state was dried, and fused in an iron pot until all the water of crystallization was driven off, and it was reduced by the application of considerable heat to a dry powder. This was decomposed in glass retorts by concentrated oil of vitriol, and the acetic acid distilled over. It contained, as usual, a mixture of sulphureous acid, which was separated by adding sugar of lead, and submitting it to another distillation.

To obtain a sufficient quantity this process was repeated three or four times, and in one of them, which did not differ in any essential particular from the others, we were agreeably surprised to find the acid, after standing all night in a low temperature, to have shot into very beautiful crystals of a tabular form, presenting the very rare substance of acetic acid in its glacial state. The crystals, when separated from the liquor in which they formed, and being dissolved, gave no trace of sulphureous acid by the addition of sugar of lead, which it seems to have excluded in crystallizing, as it was found as usual in the remaining uncrystallized part.

When the whole of the strong acid was rectified and put together, its strength was carefully ascertained by saturation with subcarbonate of soda, and was found to be 13.1 times as strong as proof acid, or to contain 65.5 per cent. of real acid.

The glacial acetic acid, which is probably the purest and most concentrated form of which it is susceptible, by the same trials, exhibited a strength 16.6 times greater than proof acid, and contained 83 per cent. of real acid.

From our stock of strong acetic acid, we prepared by dilution a regular series, as compared with proof acid, and each was carefully tried and adjusted by numerous experiments with the alkali, so that all might be depended upon as correct.

As we had found that the stronger samples when saturated with lime would not give a solution sufficiently fluid for a correct determination of its specific gravity, we resolved upon the constant use of an equal bulk of water to dilute each sample of acid to be tried, and this method is adopted with the instrument, as though it may be unnecessary for the weaker acids, yet it is better to do it in all cases, and have a uniform scale of computation, than to risk errors by a variation of the process, and a twofold mode of calculating.

In this way, we found the solutions of lime in a fit state to determine their specific gravity up to 8 times the strength of proof acid, containing therefore 40 per cent. real acid; or, in the language of the revenue, 35 per cent. over proof; and the acetometer now in use goes no higher than this point; which includes all that is likely to be made for common purposes, and a provision for laying the duties on greater strengths is made after another manner.

The following is the series of acids, which were prepared, with the simple specific gravities of each.

Proof acid the same strength as best No. 24. vinegar,	Specific gravity 1008.5
Twice the strength of proof, - -	1017.
Three times ditto, - - -	1025.7
Four times ditto, - - - -	1032.
Six times ditto, - - - -	1047.
Eight times ditto, - - -	1058.

These and other intermediate samples were saturated with hydrate of lime, and the specific gravities carefully taken, upon which were grounded the adjustments of the weights of the instrument, various trials were made to compare results, and satisfactory conclusions obtained in this respect.

The increments of gravity were found not to be in a regular series, and a provision had to be made to accommodate the instrument to the variation.

In vinegar which contains mucilage an allowance was required for the increase of weight from this cause; and as it is clearly impossible to adopt any which should meet all the minute variations in this respect, experiments were undertaken to ascertain whether something of a mean might not be assumed, which should be a sufficiently near approximation for all practical purposes; this seemed to be the case, and it was provided for, by adding a weight to be used with the others on the instrument for trying acids, which had not been purified by distillation.

The preceding is an outline of the principle on which the acetometer invented and made for the Revenue is constructed, and the mode in which the adjustment has been settled. The Honourable Board of Commissioners of the Excise directed that numerous trials should be made as to its practical utility, and have ordered its adoption by their officers, for the purposes for which it was intended.

It may be probably very useful to those who employ or purchase vinegars and acetic acid; and we may hereafter, if it be worthy a place in the Journal, offer a description of the instrument, and its application.

JOHN and PHILIP TAYLOR.

10, *Bury Court, St. Mary Axe,*
7th December, 1818.

Art. VIII. *Pitcairn's Island. From the Voyages and Travels of* Amaso Delano. *Boston,* 1817.

We are enabled to furnish our readers with some further remarks respecting the inhabitants of Pitcairn's Island, first noticed a few years ago in the Quarterly Review. It will be remembered, that Lieutenant Bligh was sent in the Bounty to the South Seas, for the purpose of collecting plants of the bread fruit for the West Indies, and part of his crew, headed by Fletcher Christian, a young man of respectable family in the north, mutinied, and turned adrift Lieutenant Bligh with the remainder of his crew, in an open boat, who succeeded after great hardships in reaching Timor, and arrived in England in 1790; and in the same year, the Pandora, Captain Edwards, sailed from England for the purpose of apprehending the mutineers, who were supposed to have gone to Otaheite, or some one of the islands in the South Seas. At Otaheite they succeeded in apprehending some of the mutineers; but no traces could be found of Christian and the rest of his crew, who, with some of the natives, both male and female, had left the island, as he said, for some one in which there was no port, where he intended to settle, and then to destroy the ship, that no traces of him might, on search, remain. After cruising about for some time, Captain Edwards determined to return to England by Endeavour Straits, and was wrecked on a reef on the 25th August, and part of the crew and four of the mutineers were lost, the remainder arrived in the ship's boats at Timor.

From this period no information respecting Christian or his companions reached England for twenty years, when, in 1809, Sir S. Smith, the Commander in Chief in the Brazil station, transmitted to the Admiralty an extract from the log-book of Captain Folgar, of the American ship Topaz; and, in the year 1813, Captain Folgar addressed a letter to the Lords of the Admiralty, stating, that he had, in February 1808, touched at Pitcairn's Island, for the purpose of procuring seals' skins, and, on approaching the shore, was met by three young men

in a canoe with a present, consisting of some fruit and a hog, and who addressed him in the English language, stating their father was an Englishman, who had sailed with Captain Bligh. On landing, Captain Folgar found an Englishman of the name of Alexander Smith, who informed him he was one of the Bounty's crew, and that after putting Captain Bligh in the boat with half the ship's company, they returned to Otaheite, where part of the crew chose to tarry; but Mr. Christian, with eight others, including himself, preferred going to a more remote place; and after making a short stay at Otaheite, where they took wives, and six men servants, proceeded to Pitcairn's Island, where they destroyed the ship, after taking every thing out of her which they thought would be useful to them: that about six years after they landed at this place, their servants attacked and killed all the English, excepting the informant, and he was severely wounded. The same night the Otaheitan widows arose and murdered all their countrymen, leaving Smith with the widows and children, where he had resided ever since without being resisted. Captain Folgar remained but a short time on the island, and, on leaving it, Smith presented him with a time-piece and an azimuth compass, which he told him belonged to the Bounty. Nearly about the same time, a further account was received from Sir Thomas Staines, of his Majesty's ship Briton, who touched at this island on the 17th September 1814. The accounts of Admiral Bligh, Captain Edwards, and Sir T. Staines, are already before the public; and to these, Captain Delano's acquaintance with Captain Folgar has enabled him to add several particulars, which we have extracted from his volume of Voyages and Travels, lately transmitted by him to Sir Joseph Banks.

Letter from Captain Folgar.

"Respected Friends, *Kendal, June* 2, 1816.

"Your favour of the 12th ult. I received last mail from the eastward, and as it returns to-morrow, I take the opportunity of forwarding you an answer.

"The Bounty, it seems, sailed from England in 1787; and after the mutiny took place, the particulars of which are so

well known, the mutineers returned with her to Otaheite. After many delays on that coast, a part of the crew, under the command of Christian, went in search of a group of islands, which you may remember to have seen on the chart placed under the head of Spanish discoveries. They crossed the situation of those imaginary isles, and satisfied themselves that none such existed. They have steered for Pitcairn's Isle, discovered by Captain Carteret, and by him laid down in latitude 25° 2′ south, and longitude, by account from Massafuero, 133° 21′ west, where they arrived, and took every thing useful out of the ship, ran her on shore, and broke her up. In February 1808, on my passage across the Pacific Ocean, I touched at Pitcairn's Island, thinking it was uninhabited; but, to my astonishment, I found Alexander Smith, the only remaining Englishman, who came to that place in the Bounty, his companions having been massacred some years before. He had with him 34 women and children. The youngest did not appear to be more than one week old. I stayed with him five or six hours; gave him an account of some things that had happened in the world since he left it, particularly their great naval victories, at which he seemed very much elated, and cried out, 'Old England for ever!' In turn he gave me an account of the mutiny, and the death of his companions, a circumstantial detail of which could, I suppose, be of little service to you in the work in which you are at present engaged. The latitude is 25° 2′ south, and the longitude, by means of nine sets of observations, 130° west. Captain Carteret might well have erred 3 or 4 degrees in his longitude, in an old crazy ship, with nothing but his log to depend on.

"I remain, &c.

"MATHEW FOLGAR."

I became acquainted in the year 1800 with Captain Folgar, observes our author, at the island of Massafuero. We were then on voyages for seals, and had an opportunity to be together for many months. His company was particularly agreeable to me, and we were often relating to each other our adventures. Among other topics of conversation, the fate of

the Bounty was several times introduced. I shewed to him the copy of the Journal of Edwards, which I had taken out at Timor, and we were both much interested to know what ultimately became of Christian, his ship, and his party. It is not easy for landsmen, who have never had personal experience of the sufferings of sailors at sea, and on savage coasts, or desolate islands, to enter into their feelings with any thing like an adequate sympathy. We had both suffered many varieties of hardships and privations, and our feelings were perfectly alive to the anxieties and distresses of a mind under the circumstances of Christian, going from all he had known and loved, and seeking as his last refuge a spot unknown and uninhabited. The spirit of crime is only temporary in the human soul, but the spirit of sympathy is eternal. Repentance and virtue succeeded to passion and misconduct; and while the public may continue to censure and frown, our hearts in secret plead for the returning and unhappy transgressor. It was with such a state of mind that Folgar and myself used to speak of the prospects before the mutineers of the Bounty, when she was last seen steering to the north-west from Otaheite on the open ocean, not to seek friends and home, but a solitary region, where no human face, besides the few now associated in exile, should ever meet their eyes.

After several years had elapsed, and we had navigated various seas, we fortunately lived to meet each other again in Boston, when it was in his power to renew our old conversation about the Bounty, and to gratify the curiosity and interest which we had so long cherished in common. The Topaz, in which he sailed and crossed the South Pacific Ocean, in search of islands for seals, being in the region of Pitcairn's island, according to Carteret's account, he determined to visit it, hoping that it might furnish him with the animals which were the objects of his voyage. As he approached the island, he was surprised to see smoke ascending from it, as Carteret had said it was uninhabited. With increased curiosity he lowered a boat into the water, and embarked in it for the shore. He was very soon met by a double canoe, made in the manner of the Otaheitans, and carrying several young men,

who hailed him in English at a distance. They seemed not to be willing to come near to him till they had ascertained who he was. He answered, and told them he was an American from Boston. This they did not immediately understand. With great earnestness they said, "You are an American; you come from America; where is America? Is it in Ireland?"

Captain Folgar thinking that he should soonest make himself intelligible to them by finding out their original country, as they spoke English, inquired, "Who are you?"—"We are Englishmen."—"Where were you born?"—"On that island which you see."—"How then are you Englishmen, if you were born on that island which the English do not own, and never possessed?"—"We are Englishmen, because our father was an Englishman."—"Who is your father?" With a very interesting simplicity they answered, "Aleck."—"Who is Aleck?"—"Don't you know Aleck?"—"How should I know Aleck?"—"Well, then, did you know Captain Bligh, of the Bounty?" At this question Folger told me, that the whole story immediately burst upon his mind, and produced a shock of mingled feelings, surprise, wonder, and pleasure, not to be described. His curiosity, which had been already excited so much on this subject, was revived, and he made as many inquiries of them as the situation in which they were would permit. They informed him, that Aleck was the only one of the Bounty's crew who remained alive on the island: they made him acquainted with some of the most important points in their history; and with every sentence increased still more his desire to visit the establishment, and learn the whole. Not knowing whether it would be proper and safe to land without giving notice, as the fears of the surviving mutineer might be awakened in regard to the object of the visit, he requested the young men to go and tell Aleck, that the master of the ship desired very much to see him, and would supply him with any thing he had on board. The canoe carried the message, but returned without Aleck, bringing an apology for not appearing, and an invitation for Captain

Folgar to come on shore. The invitation was not immediately accepted, but the young men were sent again for Aleck, to desire him to come on board the ship, and to give his assurances of the friendly and honest intention of the master. They returned, however, again, without Aleck, said that the women were fearful for his safety, and would not allow him to expose himself, or them, by leaving their beloved island. The young men pledged themselves to Captain Folgar, that he had nothing to apprehend, if he should land; that the islanders wanted extremely to see him, and that they would furnish him with any supplies which their village afforded.

After this negociation, Folgar determined to go on shore, and as he landed, he was met by Aleck and all his family, and was welcomed with every demonstration of joy and good will. They escorted him from the shore to the house of their patriarch, where every luxury they had was set before him, and offered with the most affectionate courtesy.

He, whom the youths in the canoe with such juvenile and characteristic simplicity had called Aleck, and who was Alexander Smith, now began the narrative, the most important parts of which have already been detailed. It will be sufficient for me to introduce here, such particulars only as have not been mentioned, but are well fitted to give additional interest to the general outline, by a few touches upon the minute features.

Smith said, and upon this point Captain Folgar was very explicit in his enquiry at the time, as well as in his account of it to me, that they lived under Christian's government several years after they landed; that during the whole period they enjoyed tolerable harmony; that Christian became sick and died a natural death; and that it was after this when the Otaheitan men joined in a conspiracy, and killed the English husbands of the Otaheitan women, and were by the widows killed in turn on the following night. Smith was thus the only man left upon the island. The account by Lieutenant Fitzmaurice, as he professed to receive it from the second mate of the Topaz, is, that Christian became insane, and threw himself

into the sea. The Quarterly Reviewers say, that he was shot dead while digging in the field, by an Otaheitan man, whose wife he seized for his own use. Neither of these accounts is true, as we are at liberty to affirm, from the authority of Captain Folgar whose information must be more direct and worthy of confidence than that of the second mate of Fitzmaurice, or of the Reviewers. The last are evidently desirous of throwing as much shade as possible upon the character of Christian.

Smith had taken great pains to educate the inhabitants of the island in the faith and principles of Christianity. They were in the uniform habit of morning and evening prayer, and were regularly assembled on Sunday for religious instruction and worship. It has been already mentioned, that the books of the Bounty furnished them with the means of considerable learning. Prayer books and Bibles were among them, which were used in their devotion. It is probable also, that Smith composed prayers and discourses particularly adapted to their circumstances. He had improved himself very much by reading, and by the efforts he was obliged to make to instruct those under his care. He wrote and conversed extremely well, of which he gave many proofs in his records, and in his narrative. The girls and boys were made to read and write before Captain Folgar, to shew him the degree of their improvement. They did themselves great credit in both, particularly the girls. The stationary of the Bounty was an important addition to the books, and was so abundant, that the islanders were not yet in want of any thing in this department for the progress of their school. The journal of Smith was so handsomely kept as to attract particular attention, and excite great regret that there was not time to copy it. The books upon the island must have created and preserved among the inhabitants, an interest in the character and concerns of the rest of mankind. This idea will explain much of their intercourses with Captain Folgar, and the difference between them, and the other South Sea islanders in this respect.

When Smith was asked if he had ever heard of any of the great battles between the English and French fleets in the late wars, he answered, " How could I, unless the birds of the air had been the heralds?" He was told of the victories of Lord Howe, Earl St. Vincent, Lord Duncan, and Lord Nelson. He listened with attention till the narrative was finished, and then rose from his seat, took off his hat, swung it three times round his head with three cheers, threw it on the ground, sailor like, and cried out " Old England for ever!" The young people around him appeared to be almost as much exhilarated as himself, and must have looked on with no small surprise, having never seen their patriarchal chief so excited before.

Smith was asked if he should like to see his native country again, and particularly London, his native town. He answered, that he should, if he could return soon to his island and his colony; but he had not the least wish to leave his present situation for ever. Patriotism had evidently preserved its power over his mind, but a stronger influence was generated by his new circumstances, and was able to modify its operation.

The houses of this village were uncommonly neat. They were built after the manner of those of Otaheite. Small trees are felled and cut into suitable lengths: they are driven into the earth, and are interwoven with bamboo; they are thatched with the leaves of the plantain and cocoa nut; and they have mats on the ground. My impression is, that Folgar told me some of them were built of stone.

The young men laboured in the fields and the gardens, and were employed in the several kinds of manufactures required by their situation. They made canoes, household furniture of a simple kind, implements of agriculture, and the apparatus for catching fish. The girls made cloth from the cloth tree, and attended to their domestic concerns.

They had several amusements, dancing, jumping, hopping, running, and various feats of activity. They were as cheerful, as industrious, and as healthy and beautiful, as they were tem-

perate and simple. Having no ploughs and no cattle, they were obliged to cultivate their lands by the spade and the hoe, and other instruments for manual labour.

The provision set before Captain Folgar, consisted of fowls, pork, and vegetables, cooked with great neatness, and uncommonly well. The fruits also, were excellent.

The apron and shawl worn by the girls, were made of the bark of the cloth tree. This is taken off the trunk, not longitudinally, but round, like the bark of the birch. It is beaten till it is thin and soft, and fit for use. The natural colour is buff, but it is dyed variously, red blue, and black, and is covered with the figures of animals, birds, and fish.

The inquiry was made of Smith very particularly in regard to the conduct of the sexes towards each other, and the answer was given in such a manner as entirely to satisfy Captain Folgar, that the purest morals had thus far prevailed among them. Whatever might be the liberties allowed by the few original Otaheitan women remaining, the young people were remarkably obedient to the laws of continence which had been taught them by their common instructor and guide.

Smith is said, by later visitors, to have changed his name, and taken that of John Adams. This probably arose from a political conversation between him and Captain Folgar, and from the account then given him of the Pandora, under the command of Captain Edwards, who was sent out in pursuit of the Bounty and the mutineers. The fears of Smith were somewhat excited by this last article of intelligence. As the federal constitution of the United States of America had gone into operation since the mutiny; as Captain Folgar had given an animating and patriotic account of the administration of the new government, and its effects upon the prosperity of the country; and as the name of President Adams had been mentioned, not only with respect as an able statesman and a faithful advocate of civil liberty, but as an inhabitant of the commonwealth in particular where Folgar lived; it is thought to be probable enough, that this is the circumstance which suggested the name that Smith afterwards adopted.

When he was about to leave the island, the people pressed round him with the warmest affection and courtesy. The chronometer which was given him, although made of gold, was so black with smoke and dust, that the metal could not be discovered. The girls brought some presents of cloth which they had made with their own hands, and which they had dyed with beautiful colours. Their unaffected and amiable manners, and their earnest prayers for his welfare made a deep impression upon his mind, and are still cherished in his memory. He wished to decline taking all that was brought him in the overflow of friendship, but Smith told him it would hurt the feelings of the donors, and the gifts could well be spared from the island. He made as suitable a return of presents as his ship afforded, and left this most interesting community with the keenest sensation of regret. It reminded him of Paradise, as he said, more than any effort of poetry or the imagination.

The conversations between me and Captain Folgar upon this subject, were all previous to the dates of the several printed accounts, There are a few points only in which the article in the Quarterly Review differs from the impressions upon my mind at the time when I read it. In the volume for 1810, as well as in that for 1815, the Reviewers appear to have gone out of their way, and to have taken very unworthy pains to connect slanders against my countrymen, with their remarks upon Pitcairn's island.

In regard to the extent of the population of the island, a remark may be made. Captain Folgar says, there were thirty-four in 1808. Sir Thomas Staines mentions 40 in 1814. The Quarterly Review afterward says, there were about 46, besides a number of infants. As every one of the 40 whom Sir T. Staines saw, spoke good English, and as this cannot be applied to the very young children, there must have been a larger number on the island at that time, the population now must be, at the lowest estimate, not less than 60.

ART. IX. *The Travels of* Marco Polo, *a Venetian, in the 13th Century. Translated from the Italian, with Notes by* W. Marsden, *F. R. S. &c. with a Map*, 1818.

IT is somewhat singular, that this interesting performance of Mr. Marsden, has hitherto escaped all public notice in this country. A correct translation of the Travels of Marco Polo, with a commentary, has long been a desideratum in geographical literature; and there are few persons more competent to perform this task than Mr. Marsden, in the execution of which, no pains appear to have been spared by him in the choice of the text, and in collating the various editions. The Italian version, by Ramusio, has been preferred as decidedly superior to the others. In addition to an entire new translation, Mr. Marsden has enriched his work with 1500 notes, many of the highest interest, and all shewing the learning and the knowledge of the author. The introduction contains a life of Marco Polo, with critical observations on the different editions of this work, and on the authenticity of Marco Polo's relation. In a publication of this nature, we can, of course, only be expected to furnish our readers with a very general notice of the contents of such a volume as that now before us. We shall divide what we have to say into two parts; and in the present Number, shall confine ourselves to an *abstract* from the very interesting notice of the life of Marco Polo, as given by Mr. Marsden.

" We are told, that Andrew Polo da S. Felice, a patrician or nobleman of Venice, but of Dalmatian extraction, had three sons, who were named Marco, Maffio, and Nicolo; of whom the second, who was the uncle, and the third, who was the father of our author, were merchants of that wealthy and proud city, where commerce was held in the highest estimation, and pursued on an extensive scale by its first dignitaries. These brothers, who appear to have been in partnership, being actuated by the adventurous spirit for which their countrymen were remarkable, and which was encouraged by the State, embarked together on a trading voyage to Constantinople,

between which city and Venice, the most intimate connexion subsisted at the period of which we are speaking.

"Having disposed of their Italian merchandize, they deliberated on the manner in which their capital could be made productive of further profit, when it came to their knowledge, that a market for certain costly articles was to be found amongst the Western Tartars, who, after devastating many provinces of Asia and of Europe, had settled in the vicinity of the Wolga, built cities, and assumed the forms of a regular government. They accordingly made purchases of a valuable stock of ornamental jewels, proceeded with it across the Euxine, to a port in the Crimea; and travelling from thence by land and water, reached at length the court or camp of Barkah, the brother or the son of Batu, grandson of Jengiz-khan, whose places of residence were Saraï and Bolghar, well known to the geographers of the middle ages.

"This prince we find highly praised by oriental writers for his urbanity and liberal disposition; and the traditional fame of his virtues is said still to exist in that quarter. The travellers wisely shewed their confidence in his justice, by placing all their rich commodities in his hands; and this he repaid with princely munificence: at the end of twelve months, when they were about to return, the troubles of the country, compelled them to seek their safety in a circuitous rout, which led them round the head of the Caspian, across the Taik and Jaxartes rivers, and through the deserts of Transoxiana, till they arrived at the great city of Bokhara.

"During their stay there, it happened that a Tartar noble-nobleman sent by Hulagu to Kublaï, his brother, made that city his halting place. From motives of curiosity, he desired an interview with the Italians, was gratified with hearing them converse in his native language; derived pleasure from their intelligent communications, and proposed to them, that they should accompany him to the Emperor's Court, where he assured them of meeting a favourable reception, and an ample compensation for the trouble of their journey. To a compliance with this they were decided, as much by the difficulties that presented themselves in their means of returning, as by

the spirit of enterprise, or the prospect of wealth, they prosecuted their journey towards what they considered to be the extremity of the East; and after travelling twelve months, reached the Imperial residence. The manner in which they were received by the Grand Khan was gracious and encouraging.

Satisfied with the correctness of their statements, and of their sufficiency as men of business, he determined upon sending them back to Italy, accompanied by one of his own officers, as his Ambassadors to the see of Rome. With the assistance of the imperial tablet or passport with which they were provided, and which commanded respect, and insured them accommodation in all the places through which their route lay, they proceeded towards the shores of the Mediterranean, and, at the expiration of three years, reached the port of Geazza, or Ajas, in the kingdom of the Lesser Armenia. At this place they embarked for Acre, then in the possession of the Christians, where they arrived in the month of April, 1269.

Upon landing there, they received the first intelligence of the death of Pope Clement IV., which happened in November, 1268; and it was recommended to them by the Legate on the spot, to take no further steps in the business of their embassy until the election of a new pope. This interval they thought would be most properly employed in a visit to their family; and, for that purpose, they engaged a passage in a ship bound to Negropont and Venice. Upon their arrival, Nicolo Polo found that his wife, whom he had left with child, was dead, after producing a son, to whom she had given the name of Marco, in respect for the memory of her husband's eldest brother, and who was now advancing towards the age of manhood. Such were the circumstances under which the author of the Travels first makes his appearance.

In consequence of the factions that prevailed in the sacred college, the election was so much protracted, that our Venetian travellers became impatient of the delay, and apprehensive of incurring the displeasure of their august benefactor and employer. After having resided two years in Italy, they

adopted therefore the resolution of returning directly to the Legate in Palestine; and, on this occasion, they were accompanied by young Marco, then in his 17th or 18th year. Having, upon their arrival at Acre, prevailed on his Eminence to furnish them with letters to the Tartar Emperor, they embarked for Ayas; but scarcely had they got under weigh, when advice was received at the former place, of the choice of the cardinals having at length fallen upon the Legate himself, M. Tebaldo de Vicenza, who assumed the name of Gregory X. He lost no time in recalling our Venetians, and in preparing for them letters papal, in a more ample and dignified form, to which he added his benediction, and once more dispatched them, along with two friars of the order of Preachers, who were to be the bearers of his presents.

These transactions took place about the end of the year 1271, at which period the northern parts of Syria were invaded by the Soldan of Egypt; and such was the alarm caused by his approach to the borders of Armenia Minor, that the two friars were deterred from preceeding, and returned for safety to the coast. The Polo family, in the mean time, prosecuted their journey to the interior of Asia, in a north-easterly direction, undismayed by the prospects of dangers they might have to encounter. Their difficulties appear to to have been only such as arose from natural causes. Of their particular course few indications are given, but it must evidently have been through the Greater Armenia, Persian Irak, Khorasan, and by the city of Balkh, into the country of Badakhashan, amongst the sources of the Oxus, where they remained twelve months. This long detention might have been occasioned by the necessity of waiting for a large assemblage of travelling merchants, under an adequate escort, preparatory to crossing the great ranges of mountains called in our maps the Belut-tah and Mug-tag; but it may also be accounted for by the circumstance of Marco's illness at this place, which, he tells us, was cured by removing his residence from the valley to the summit of an adjoining hill. Their road now lay through the valley named Vokhan, from whence they ascended to the elevated and wild regions of Pamer and Belôr, on their

way to the city of Kashghar, which belonged to the extensive dominions of the Grand Khan, and is known to have been a principal place of resort for caravans. After speaking incidentally of Samarkand, which lay to the westward of their route, mention is also made of Yerken; but they proceeded directly to Khoten, a town of much celebrity, and afterwards through places little known to geographers, till they reached the desert of Lop or Kobi, which is circumstantially described. This being traversed in a tedious journey of thirty days, they entered the comprehensive district of Tangut, and passed through the country of those whom the Chinese call Si-fan, or Tu-fan, as well as the strong place named Sha-cheu, or the town of the sands. From thence the direct road is to So-cheu, at the western extremity of the province of Shen-si. This place is within the boundary of what is now China proper, but was then, as well as the city of Can-cheu, considered as belonging to Tangut.

At Kan-cheu they experienced another long delay, which our author briefly says, was occasioned by the state of their concerns. From Kan-cheu it would seem that they took the road of Sining, (just within the nominal line of the great wall, which on that side was built of sandy earth, and had mostly fallen to decay,) leading through the heart of the province of Shen-si, and directly into that of Shan-si. In the capital city of this latter, named Tai-yuen-fu, it was, that the Grand Khan, who, in the early part of his reign, is known to have made it his winter residence, received notice of their arrival in his dominions; and, as their account says, that at the distance of forty days journey from that place, he sent forward directions for preparing every thing necessary for their accommodation, we may understand this to mean, that upon his coming to the western part of China, and hearing of the detension of his Italian messengers at Kan-cheu, he commanded that they should be immediately forwarded to his presence, at his expense, and with the attentions usually shown to foreign ambassadors.

The reception given to them by the Emperor was as favourable as they were justified in expecting. After the customary

prostrations and delivery of the letters, they were desired, to relate all the circumstances that had taken place in the business of their mission, to which he condescendingly listened. He commended their zeal, and accepted with complacency the presents from the Pope ; and with reverence, a vessel of the holy oil from the sepulchre of our Lord, that had been brought from Jerusalem at his desire, and which he concluded, from the value set upon it by Christians, might possess extraordinary properties. Observing young Marco in the assemblage, he made enquiries respecting him, and being informed that he was the son of Nicolo, he honoured him with his particular notice, took him under his protection, and gave him an appointment in his household. In this situation he soon became distinguished for his talents, and respected by the Court. He adopted the manners of the country, and acquired a competent knowledge of the four languages most in use; which might probably have been the Mongul, that of Turkistân, (including the Ighûr,) the Machû of eastern Tartary, and the Chinese. Thus accomplished, he became a favourite with, and highly useful to his master, who employed him on services of importance in various parts of the empire, even to the distance of six months journey. On these missions he availed himself of every oppportunity of examining into the circumstances of the countries he visited, and the customs of their inhabitants, and made notes of what he observed, for the information of the Grand Khan, whose curiosity on such subjects appears to have been insatiable; and to these notes it is that we are indebted for the substance of that account of his Travels, which, after his return, he was induced to give to the world, but which was certainly not in his contemplation at the time. It cannot be doubted, that in recompense for these exertions, he experienced many flattering marks of royal favour; but the most distinguished, or rather the only one of his honours that is recorded, arose out of the occasion of a member of one of the great tribunals being nominated fuyuen, or governor of the city of Yang-cheu-fu, in the province of Kiangnan, who not being able to proceed to his charge, our young Venetian was appointed to act as his de-

puty, and held this high office during the usual period of three years. Of the correctness of this fact, in which there is nothing improbable, as Kublaï is known to have made use of Arabians, Persians, and many other foreigners, as his political instruments, no stronger evidence is necessary than the modest incidental manner in which he connects it with the description of the place.

That his father and uncle were partakers of the monarch's regard, is shewn by his subsequent unwillingness to be deprived of their services. In one instance at least, and that immediately after their arrival at his court, they were eminently useful to him, in suggesting to his officers the employment of certain projectile machines or catapultæ, and superintending their constructions; thereby contributing in an essential manner to the fall of the strong and important Chinese city of Siang-yang-fu, which had resisted the efforts of his besieging army for upwards of three years.

When about 17 years had elapsed since the arrival of our travellers within the territories of the Grand Khan, the natural desire of revisiting their native land, notwithstanding the splendid advantages of their situation, began to work upon their minds with considerable force, and the great age of their protector weighed strongly with them in increasing the desire of their departure, though they could not prevail on him to permit their departure. From this state of impatience and disappointment, it was their good fortune to be relieved in a manner wholly unexpected, which shall be here explained. An embassy happened, about that time, to arrive at the court of Kublaï, from a Moghul Tartar prince, named Arghun, the grandson of Hulagu (and consequently the grand nephew of the Emperor) who ruled in Persia. Having lost his principal wife, who was a princess of the imperial stock, and who on her death-bed had intreated that he would not disgrace her memory by forming an alliance with any inferior house, he sent this deputation to his sovereign and the head of his family, to solicit from him a wife of their own lineage. The request was readily complied with, and a princess was selected from amongst his grand children, who had attained her 17th year.

The ambassadors being satisfied as to her beauty and accomplishments, set out with her on their journey to Persia, with a numerous suite, to do honour to the betrothed queen; but after several months travelling, found themselves obstructed from proceeding, by the disturbed state of the country through which their rout lay, and were under the necessity of returning to the capitel. Whilst they were in this embarrassed situation, Marco Polo, who had been on a voyage to some of the East India islands, came into port, and laid before his master the observations he had made respecting the safe navigation of those seas; circumstances which reaching their ears, induced them to have a communication with the Venetian family. Upon its being understood that they had all a common interest, each party being anxiously desirous of effecting their return to their own country, it was arranged between them, that the Persians should urgently represent to the Grand Khan, the expediency of their availing themselves of the experience of the Christians in maritime affairs, to convey their precious charge by sea to the Gulph of Persia; as they were debarred from returning thither by land. Dissatisfactory as we may suppose the proposition to have been to him, he could not, in such a dilemma, refuse to give his consent. Preparations were accordingly made on a grand scale for this important expedition. Fourteen ships of four masts, and some of them with crews of 250 men, were equipped and provisioned for two years. When the period of their departure was at hand, the benevolent monarch addressed the Polo family in terms of kind regard, and required from them a promise, that after having visited their own country and kindred, they would return to his service. He, at the same time, gave them authority to act as his ambassadors to the principal courts of Europe, furnished them with passports necessary for their protection and accommodation in the countries acknowledging his sovereignty, and made them presents of many valuable jewels. Thus honourably dismissed, they embarked together with the Persian noblemen, and the young Queen, with her attendants in the Pe-ho river, as may be presumed

from its vicinity to the capital, in order to proceed to the place of their remote destination.

In the details that are given of the voyage, there is but little that personally regards our author, and the relation shall here be stated as succinctly as possible. The first place at which they appear to have touched (if the expedition did not in fact proceed from thence in the first instance) was the port of Zartun, in the province of Fo-hien, supposed to be either Tsuen-chew, or the neighbouring port of Hia-muen, by us called Anroy. Passing by the island of Hai-nan, they kept along the coast of Anan or Kochin-China, to the adjoining country of Tsiampa, which Marco Polo informs us he had previously visited in the year 1280. Mention is next made of the island of Java, although it is evident from the circumstances, that they did not touch there, and also of two uninhabited islands near the coast of Kamboja. From the latter they steered for the island of Bintan, near the eastern entrance of the straits of Malacca. From this place, where they seem to have acquired some knowledge of the kingdom of the Malays, at the extremity of the Peninsula, they made a short run in the north-eastern coast of Java Minor, by which is meant Sumatra. This island becomes the subject of more particular description than almost any other place visited. In one of its ports, they are said to have been detained five months, waiting for a favourable season to pursue their voyage across the Bay of Bengal. Upon leaving this port, mention is made of one of the Nicobar islands, and of those called the Andamans, the natives of which are represented as brutish in their manners, and in their appearance scarcely human.

The fine island of Ceylon is next visited, and its celebrated peak particularly noticed. From thence they cross the narrow strait, to the southern part of the coast of the Peninsula, called by our author in imitation of the Arabian Persian writers, the county of Maabar, which must not be confounded with Malabar On this occasion, he gives a circumstantial account of the famous pearl fishery. He also relates the traditions of the people respecting the martyrdom of St. Thomas the Apostle, and the miracle wrought at his tomb. Other

places within the ancient kingdom of Narsinga, although perhaps not actually visited by him, and particularly Masulipatam, with the diamond mines of Golconda, are then mentioned. Of these last, on the faith of the natives, some extraordinary tales are related. Cape Comorin, and several towns and districts on the south western coast, are then spoken of; the produce of pepper is noticed, and also the natural strength of the country from its mountainous barrier. The pirate coast, which he calls by the name of Malabar, although that belongs in strictness to the more southern part, is next described, and afterwards in succession, Guzzerat, Kambaia, Summenat, and the country of Makran, which he terms the last, as being the most western province of his greater division of India, beginning with Maabar already mentioned. Which of these places they really touched at, and which of them were known only by the accounts received from the Arabian and other navigators of the Indian seas, does not distinctly appear, and can only be inferred from the greater or less degree of precision with which they are noticed. Of the islands of Socatra, Madagascar, and Zenzibar, or the southern part of the Peninsula of Africa, he professedly speaks upon authority of persons with whom he had conversed, and who had shewn him maps of those parts. The same may be said of Abyssinia and the cities of Aden, Sheher, Dafar, and Kelhat, on the Arabian coast. At Ormuz, in the Persian Gulf, the course of his description (for after the first long chapter of the work, the form of a narrative is not observed) may be considered as brought to a close; and there is every reason to infer, that the Chinese expedition, after a navigation of 18 months in the Indian seas, terminated at that place. Of the return of the ships, and surviving part of the crews, (600 of whom, with two of the Persian noblemen, having died on the passage) we have not any record whatever; and it is most probable, that deprived of the energy of the Europeans, the fleet never found its way back to China, although many of the individuals may have effected their passage by the trading ships. An event however had in the mean time occurred, which rendered the fate of this hazardous undertaking a subject of less interest

at the court of Pekin, than it would otherwise have been. This was the death of the venerable Emperor Kublaï, which took place in the beginning of the year 1294.

(*To be continued.*)

Art. X. *An Account of some Experiments made on the Body of a Criminal immediately after Execution, with Physiological and Practical Observations. By* Andrew Ure, *M. D. M. G. S.*

(Read at the Glasgow Literary Society, Dec. 10th, 1818.)

Convulsions accidentally observed in the limbs of dead frogs, originally suggested to Galvani, the study of certain phenomena, which from him have been styled Galvanic. He ascribed these movements to an electrical fluid or power, innate in the living frame, or capable of being evolved by it, which he denominated Animal Electricity. The *Torpedo*, *Gymnotus* and *Silurus Electricus*, fish endowed with a true electrical apparatus, ready to be called into action by an effort of their will, were previously known to the naturalist, and furnished plausible analogies to the philosopher of Bologna. Volta, to whom this science is indebted for the most brilliant discoveries on its principles, as well as for its marvellous apparatus, justly called by his name, advanced powerful arguments against the hypothesis of Galvani. He ascribed the muscular commotions, and other phenomena, to the excitation of common electricity, by arrangements previously unthought of by the scientific world; merely by the mutual contact of dissimilar bodies; metals, charcoal, and animal matter, applied either to each other, or conjoined with certain fluids. And at the present day, perhaps the only facts which seem difficult to reconcile with the beautiful theory of electro-motion, invented by the Pavian Professor, are some experiments of Aldini, the nephew of the original discoverer.

In these experiments, neither metals nor charcoal was employed. Very powerful muscular contractions seem to have been excited, in some of the experiments, by bringing a part of a warm-blooded, and of a cold-blooded animal, into contact with each other; as the nerve and muscle of a frog, with the bloody flesh of the neck of a newly decapitated ox. In other experiments, the nerves and muscles of the same animal, seem to have operated Galvanic excitation; and again, the nerve of one animal acted with the muscle of another. He deduces from his experiments, an inference in favour of his uncle's hypothesis, that a proper animal electricity is inherent in the body, which does not require the assistance of any external agent, for its developement. Should we admit the reality of these results, we may perhaps venture to refer them to a principle analogous to Sir H. Davy's pile, or Voltaic circuit, of two dissimilar liquids and charcoal. This part of the subject is however involved in deep obscurity.

Many experiments have been performed, in this country and abroad, on the bodies of criminals, soon after their execution. Vassali, Julio, and Rossi, made an ample set, on several bodies decapitated at Turin. They paid particular attention to the effect of Galvanic electricity on the heart, and other involuntary muscles; a subject of much previous controversy. Volta asserted, that these muscles are not at all sensible to this electric power. Fowler maintained, that they were affected; but with difficulty, and in a slight degree. This opinion was confirmed by Vassali; who further shewed, that the muscles of the stomach, and intestines, might thus also be excited. Aldini, on the contrary, declared, that he could not affect the heart, by his most powerful Galvanic arrangements.

Most of the above experiments were however made, either without a voltaic battery, or with piles, feeble in comparison with those now employed. Those indeed performed on the body of a criminal, at Newgate, in which the limbs were violently agitated; the eyes opened and shut; the mouth and jaws worked about, and the whole face thrown into frightful convulsions, were made by Aldini, with, I believe, a considerable series of voltaic plates.

A circumstance of the first moment, in my opinion, has been too much overlooked in experiments of this kind,—that a muscular mass through which the galvanic energy is directly transmitted, exhibits very weak contractile movements, in comparison with those which can be excited by passing the influence along the principal nerve of the muscle. Inattention to this important distinction, I conceive to be the principal source of the slender effects hitherto produced in such experiments on the heart, and other muscles independent of the will It ought also to be observed, that too little distinction has been made between the positive and negative poles of the battery; though there are good reasons for supposing, that their powers on muscular contraction are by no means the same.

According to Ritter, the electricity of the positive pole augments, while the negative diminishes the actions of life. Tumefaction of parts is produced by the former; depression by the latter. The pulse of the hand, he says, held a few minutes in contact with the positive pole, is strengthened; that of the one in contact with the negative is enfeebled; the former is accompanied with a sense of heat, the latter with a feeling of coldness. Objects appear to a positively electrified eye, larger, brighter, and red; while to one negatively electrified, they seem smaller, less distinct, and bluish,—colours indicating opposite extremities of the prismatic spectrum. The acid and alkaline tastes, when the tongue is acted on in succession by the two electricities, are well known, and have been ingeniously accounted for by Sir H. Davy, in his admirable Bakerian Lectures. The smell of oxymuriatic acid, and of ammonia, are said by Ritter, to be the opposite odours, excited by the two opposite poles; as a full body of sound and a sharp tone are the corresponding effects on the ears. These experiments require verification.

Consonant in some respects, though not in all, with these statements, are the doctrines taught by a London practitioner, experienced in the administration of medical electricity. He affirms, that the influence of the electrical fluid of our common machines, in the cure of disease, may be referred to three

distinct heads; first, the form of *radii*, when projected from a point positively electrified; secondly, that of a star, or the negative fire, concentred on a brass ball; thirdly, the Leyden explosion. To each of these forms he assigns a specific action. The first acts as a sedative, allaying morbid activity; the second as a stimulant, and the last has a deobstruent operation, in dispersing chronic tumours. An ample narrative of cases is given in confirmation of these general propositions. My own experience leads me to suppose, that the negative pole of a voltaic battery, gives more poignant sensations than the positive.

But, unquestionably, the most precise and interesting researches on the relation between voltaic electricity and the phenomena of life, are those contained in Dr. Wilson Philip's Dissertations in the Philosophical Transactions, as well as in his Experimental Inquiry into the Laws of the Vital Functions, more recently published.

In his earlier researches, he endeavoured to prove, that the circulation of the blood, and the action of the involuntary muscles, were independent of the nervous influence. In a late paper, read in January 1816, he shewed the immediate dependence of the secretory functions on the nervous influence.

The eighth pair of nerves distributed to the stomach, and subservient to digestion, were divided by incisions in the necks of several living rabbits. After the operation, the parsley which they ate remained without alteration in their stomachs; and the animals, after evincing much difficulty of breathing, seemed to die of suffocation. But when in other rabbits, similarly treated, the galvanic power was transmitted along the nerve, below its section, to a disc of silver, placed closely in contact with the skin of the animal, opposite to its stomach, no difficulty of breathing occurred. The voltaic action being kept up for twenty-six hours, the rabbits were then killed, and the parsley was found in as perfectly digested a state, as that in healthy rabbits fed at the same time; and their stomachs evolved the smell peculiar to that of a rabbit during

digestion. These experiments were several times repeated with similar results.

Hence it appears, that the galvanic energy is capable of supplying the place of the nervous influence, so that while under it, the stomach otherwise inactive, digests food as usual. I am not, however, willing to adopt the conclusion drawn by its ingenious author, that the " identity of galvanic electricity and nervous influence is established by these experiments." They clearly shew a remarkable analogy between these two powers, since the one may serve as a substitute for the other. It might possibly be urged by the anatomist, that, as the stomach is supplied by twigs of other nerves, which communicate under the place of Dr. Philips' section of the *par vagum*, the galvanic fluid may operate merely as a powerful stimulus, exciting those slender twigs to perform such an increase of action as may compensate for the want of the principal nerve. The above experiments were repeated on dogs, with like results; the battery never being so strong, as to occasion painful shocks.

The removal of dyspnœa, as stated above, led him to try galvanism as a remedy in asthma. By transmitting its influence from the nape of the neck to the pit of the stomach, he gave decided relief in every one of twenty-two cases, of which four were in private practice, and eighteen in the Worcester Infirmary. The power employed varied from ten to twenty-five pairs.

The general inferences deduced by him from his multiplied experiments, are, that voltaic electricity is capable of effecting the formation of the secreted fluids when applied to the blood in the same way in which the nervous influence is applied to it; and that it is capable of occasioning an evolution of caloric from arterial blood. When the lungs are deprived of the nervous influence by which their function is impeded, and even destroyed, when digestion is interrupted, by withdrawing this influence from the stomach, these two vital functions are renewed by exposing them to the influence of a galvanic trough. " Hence," says he, " galvanism seems capable of performing all the functions of the nervous influence in the

animal economy; but obviously it cannot excite the functions of animal life, when acting on parts endowed with the living principle."

M. Gallois, an eminent French physiologist, had endeavoured to prove, that the motion of the heart depends entirely upon the spinal marrow, and immediately ceases when the spinal marrow is removed or destroyed. Dr. Philip appears to have refuted this notion by the following experiments. Rabbits were rendered insensible by a blow on the occiput; the spinal marrow and brain were then removed, and the respiration kept up by artificial means: the motion of the heart, and the circulation, were carried on as usual. When spirit of wine, or opium, was applied to the spinal marrow or brain, the rate of the circulation was accelerated.

These general physiological views will serve, I hope, as no inappropriate introduction to the detail of the galvanic phenomena, exhibited here on the 4th of November, in the body of the murderer Clydsdale; and they may probably guide us to some valuable practical inferences.

The subject of these experiments, was a middle sized, athletic, and extremely muscular man, about thirty years of age. He was suspended from the gallows nearly an hour, and made no convulsive struggle after he dropped; while a thief executed along with him, was violently agitated for a considerable time. He was brought to the anatomical theatre of our university in about ten minutes after he was cut down. His face had a perfectly natural aspect, being neither livid nor tumefied; and there was no dislocation of his neck.

Dr. Jeffray, the distinguished Professor of Anatomy, having on the preceding day requested me to perform the galvanic experiments, I sent to his theatre with this view, next morning, my *minor* voltaic battery, consisting of 270 pairs of four inch plates, with wires of communication, and pointed metallic rods with insulating handles, for the more commodious application of the electric power. About five minutes before the police officers arrived with the body, the battery was charged with a dilute nitro-sulphuric acid, which speedily brought it into a

state of intense action. The dissections were skilfully executed by Mr. Marshall, under the superintendance of the Professor.

Exp. 1. A large incision was made into the nape of the neck, close below the *occiput*. The posterior half of the *atlas vertebra* was then removed by bone forceps, when the spinal marrow was brought into view. A considerable incision was at the same time made in the left hip, through the great gluteal muscle, so as to bring the sciatic nerve into sight; and a small cut was made in the heel. From neither of these did any blood flow. The pointed rod connected with one end of the battery was now placed in contact with the spinal marrow, while the other rod was applied to the sciatic nerve. Every muscle of the body was immediately agitated with convulsive movements, resembling a violent shuddering from cold. The left side was most powerfully convulsed at each renewal of the electric contact. On moving the second rod from the hip to the heel, the knee being previously bent, the leg was thrown out with such violence, as nearly to overturn one of the assistants, who in vain attempted to prevent its extension.

Exp. 2. The left phrenic nerve was now laid bare at the outer edge of the *sterno-thyroideus* muscle, from three to four inches above the clavicle; the cutaneous incision having been made by the side of the sterno-cleido-mastoideus. Since this nerve is distributed to the diaphragm, and since it communicates with the heart through the eighth pair, it was expected, by transmitting the galvanic power along it, that the respiratory process would be renewed. Accordingly, a small incision having been made under the cartilage of the seventh rib, the point of the one insulating rod was brought into contact with the great head of the diaphragm, while the other point was applied to the phrenic nerve in the neck. This muscle, the main agent of respiration, was instantly contracted, but with less force than was expected. Satisfied, from ample experience on the living body, that more powerful effects can be produced in galvanic excitation, by leaving the extreme com-

municating rods in close contact with the parts to be operated on, while the electric chain or circuit is completed, by running the end of the wires along the top of the plates in the last trough of either pole, the other wire being steadily immersed in the last cell of the opposite pole, I had immediate recourse to this method. The success of it was truly wonderful. Full, nay, laborious breathing, instantly commenced. The chest heaved, and fell; the belly was protruded, and again collapsed, with the relaxing and retiring diaphragm. This process was continued, without interruption, as long as I continued the electric discharges.

In the judgment of many scientific gentlemen who witnessed the scene, this respiratory experiment was perhaps the most striking ever made with a philosophical apparatus. Let it also be remembered, that for full half an hour before this period, the body had been well nigh drained of its blood, and the spinal marrow severely lacerated. No pulsation could be perceived meanwhile at the heart or wrist; but it may be supposed that, but for the evacuation of the blood,—the essential stimulus of that organ,—this phenomenon might also have occurred.

Exp. 3. The supra-orbital nerve was laid bare in the forehead, as it issues through the supra-ciliary *foramen*, in the eyebrow: the one conducting rod being applied to it, and the other to the heel, most extraordinary grimaces were exhibited every time that the electric discharges were made, by running the wire in my hand along the edges of the last trough, from the 220th to the 227th pair of plates; thus fifty shocks, each greater than the preceding one, were given in two seconds: every muscle in his countenance was simultaneously thrown into fearful action; rage, horror, despair, anguish, and ghastly smiles, united their hideous expression in the murderer's face, surpassing far the wildest representations of a Fuseli or a Kean. At this period several of the spectators were forced to leave the apartment from terror or sickness, and one gentleman fainted.

Exp. 4. The last galvanic experiment consisted in trans-

mitting the electric power from the spinal marrow to the ulnar nerve, as it passes by the internal condyle at the elbow; the fingers now moved nimbly, like those of a violin performer; an assistant, who tried to close the fist, found the hand to open forcibly, in spite of his efforts. When the one rod was applied to a slight incision in the tip of the fore-finger, the fist being previously clenched, that finger extended instantly; and from the convulsive agitation of the arm, he seemed to point to the different spectators, some of whom thought he had come to life.

An hour having been spent in these galvanic operations, I then prepared to execute an experiment with the view of determining, by a new and simple mode, the quantity of residual air in the lungs. This physiological problem has been attempted to be solved in a great variety of ways; and the wide discrepancy of the results obtained by eminent philosophers, satisfied me, that the methods of operating hitherto adopted, must have been more or less erroneous. The *trachea* being cut across below the *pomum Adami*, a short brass tube was introduced into it, and firmly secured in its place by hooping with packthread; into this tube a stop-cock was screwed, air-tight. A glass globe of 159.3 cubic inches in capacity, with an attached brass cap and stop-cock for weighing gases, being previously exhausted by an excellent air-pump, and nicely poised at a delicate balance, was now connected with the stop-cock in the *trachea*. A small opening was then carefully made on each side into the *thorax*. When the communication between the lungs and the globe was opened by turning the stop-cocks, the air was heard to rush forcibly into the latter with a whizzing sound; when this ceased, the stop-cocks were again shut, the globe unscrewed, and suspended at the balance.

Its increase of weight was found to be exactly 31.8 grains. To ascertain whether the lungs and attached brass tube were perfectly air-tight, the globe was again connected with the windpipe, as before, and on re-opening the communication, a momentary puff of air only was heard to enter the globe; after

which no sound of moving air could be perceived: the additional increase of weight was only 1.6 grains, though the connection was left open for some time, and though the globe was not more than two-thirds replenished with air, or the included air was only two-thirds of the atmospherical tension.

By subsequent examination, the bulk of these 33.4 grains of air was found to be 105.2 cubic inches, consisting of about 91 of azote, mixed with a little oxygen, and 14.2 of carbonic acid. It is possible, that a larger proportion of carbonic acid than 13½ *per cent.*, would have been found before the galvanic respiration; though from the accurate experiments of MM. Allen and Pepys, we see, that breathing becomes intolerable with atmospherical air, charged with 10 per cent. of that noxious gas. By the preceding method, it is obvious that the whole of the residual air may be readily extracted from the lungs without doing the slightest violence to their texture, while the fallacies incident to some of the former plans of experimenting are avoided; yet my result coincides very well with Dr. Goodwyn's determination of 109 cubic inches, obtained in a very different way. Variations must be expected, according to the size of the person's *thorax*.

In deliberating on the above galvanic phenomena, we are almost willing to imagine, that if, without cutting into and wounding the spinal marrow and blood-vessels in the neck, the pulmonary organs had been set a-playing at first, (as I proposed) by electrifying the phrenic nerve (which may be done without any dangerous incision,) there is a probability that life might have been restored. This event, however little desirable with a murderer, and perhaps contrary to law, would yet have been pardonable in one instance, as it would have been highly honourable and useful to science. From the accurate experiments of Dr. Philip, it appears that the action of the diaphragm and lungs is indispensible towards restoring the suspended action of the heart and great vessels, subservient to the circulation of the blood.

It is known, that cases of death-like lethargy, or suspended animation, from disease and accidents have occurred, where

life has returned, after longer interruption of its functions, than in the subject of the preceding experiments. It is probable, when apparent death supervenes from suffocation with noxious gases, &c. and when there is no organic læsion, that a judiciously directed galvanic experiment, will, if any thing will, restore the activity of the vital functions. The plans of administering voltaic electricity hitherto pursued in such cases, are, in my humble apprehension, very defective. No advantage, we perceive, is likely to accrue from passing electric discharges across the chest, directly through the heart and lungs. On the principles so well developed by Dr. Philip, and now illustrated on Clydsdale's body, we should transmit along the channel of the nerves, that substitute for nervous influence, or that power which may perchance awaken its dormant faculties. Then, indeed, fair hopes may be formed of deriving extensive benefit from galvanism; and of raising this wonderful agent to its expected rank, among the ministers of health and life to man.

I would, however, beg leave to suggest another nervous channel, which I conceive to be a still readier and more powerful one, to the action of the heart and lungs than the phrenic nerve. If a longitudinal incision be made, as is frequently done for aneurism, through the integuments of the neck at the outer edge of the *sterno-mastoideus* muscle, about halfway between the clavicle and angle of the lower jaw; then on turning over the edge of this muscle, we bring into view the throbbing carotid, on the outside of which, the *par vagum*, and great sympathetic nerve, lie together in one sheath. Here, therefore, they may both be directly touched and pressed by a blunt metallic conductor. These nerves communicate directly, or indirectly, with the phrenic; and the superficial nerve of the heart is sent off from the sympathetic.

Should, however, the phrenic nerve be taken, that of the left side is the preferable of the two. From the position of the heart, the left phrenic differs a little in its course from the right. It passes over the *pericardium*, covering the *apex* of the heart.

While the point of one metallic conductor is applied to the

nervous cords above described, the other knob ought to be firmly pressed against the side of the person, immediately under the cartilage of the seventh rib. The skin should be moistened with a solution of common salt, or what is better, a hot saturated solution of sal-ammoniac, by which means, the electric energy will be more effectually conveyed through the cuticle, so as to complete the voltaic chain.

To lay bare the nerves above described, requires, as I have stated, no formidable incision, nor does it demand more anatomical skill, or surgical dexterity, than every practitioner of the healing art ought to possess. We should always bear in mind, that the subject of experiment is at least insensible to pain; and that life is at stake, perhaps, irrecoverably gone. And assuredly, if we place the risque and difficulty of the operations, in competition with the blessings, and glory consequent on success, they will weigh as nothing, with the intelligent and humane. It is possible, indeed, that two small brass knobs, covered with cloth moistened with solution of sal-ammoniac, pressed above and below, on the place of the nerve, and the diaphragmatic region, may suffice, without any surgical operation. It may first be tried.

Immersion of the body in cold water accelerates greatly the extinction of life arising from suffocation; and hence less hopes need be entertained, of recovering drowned persons after a considerable interval, than when the vital heat has been suffered to continue with little abatement. None of the ordinary practices judiciously enjoined by the Humane Society, should ever on such occasions be neglected. For it is surely criminal to spare any pains which may contribute, in the slightest degree, to recal the fleeting breath of man to its cherished mansion.

Art. XI. *Extract of a Letter from an Officer in the Arctic Expedition.*

"The ships having completed their stores at Sheerness on the 25th of April, sailed to the northward, and anchored in Lerwick harbour on Sunday, 1st of May, where we experienced the greatest hospitality and kindness from the inhabitants; and we cannot forbear mentioning the names of Messrs. Spence, Edmondson, and Mouatt, to whom we were much indebted for the kind interest they took in procuring us every comfort they thought we should have occasion for. The Trent having made some water in our passage here, was employed in stopping her leak. A tent was pitched on Brassa Isle, and several of the philosophical instruments landed; but the weather during our stay here was so unfavourable for observation, that Mr. Fisher was not able to obtain a single transit, having in view the important object of ascertaining the length of a pendulum vibrating seconds; other observations were however made on the magnetic dip, variation, &c.

"We first made the ice about the 27th of May, near Cherry Island, which is small, and of remarkable appearance, being composed of many high and pointed rocks or cliffs, and in our bearing, looks as if rent asunder by some convulsion of nature; it lies on the south-east part of Spitzbergen, from which it is distant about 150 miles. During a few days previous to our making the ice, we experienced a great change of weather, the thermometer having fallen very considerably, and now continued below 32° Fahrenheit; we had also frequent and heavy falls of snow; and for several days in the latter part of May, the thermometer fell to 18° or 14° below the freezing point. We soon descried the lofty and snow-capped rocks or precipices which compose Spitzbergen, the cheerless, bleak, and sterile aspect of which it is impossible to describe. Running along the western side of the island, our progress was stopped by immense barriers of ice, which extended in every direction as far as the eye could reach, and joining the

land to the northward, blocked up all the harbours. We succeeded, however, in gaining a high northern latitude, viz. about 80°; but as we had parted from our consort a few days before in a heavy gale of wind, we returned in quest of her, and were fortunate enough to fall in with her on the following day. We now put into Magdalena Bay, in lat. 79° 33′ N., and long. 11° E. The upper and inner part of this bay was found so choked up with ice, which was now beginning to break up, that our situation here became very critical: having surveyed it, we again put to sea, and ran along the edge of the ice to the westward, which every where presented the appearance of a solid body. On the 10th of June we fell in with several sail of Greenlandmen, when we were sorry to learn, that no hope existed of getting to the northward by stretching to the westward; and it was the unanimous opinion of the masters of these ships, that to gain a high northern latitude, we must penetrate to the eastward, that is to say, we must stand in with, or near the land of Spitzbergen. In consequence of this information, as well as the observations we had already made, and the decisive opinion of our pilots, we retraced our path to the northward, and were soon completely beset in the ice. You cannot form any conception of the truly picturesque, and often solemn grandeur of such a scene. Conceive two vessels hemmed in, jammed, and completely surrounded by immense masses of ice, of the rudest, and often of the most fantastic form; the two ships appearing, as it were, like specks in the midst of a vast extended plain of alabaster whiteness, and to which the eye can assign no limits. When the sun shone bright, whether at mid-day or mid-night, but particularly at the latter period, its beams assumed a softer hue, and shed a mellower tint on the immense sheet of surrounding ice, while the steep and towering summit of Spitzbergen, forming the back-ground, combined to render the whole truly grand and interesting. In this situation we remained ten or twelve days, nearly fixed bodies, except when the different currents changed our situation, which was indicated to us only by altering the bearings of the land, from which we were distant eight or ten leagues. At

length we were extricated from our perilous situation by the ice partially opening, so as to enable us to force our way out.

"We now ranged along the edge of the ice, endeavouring, if possible, to discover some vacancy by which we might penetrate northward; but we did so in vain. On the 26th of June we again came to an anchor in Fair Haven, which is situated between two islands, called Vogel Sang and Clooen Cliff; on those, and the neighbouring islands, we discovered numerous herds of deer; and in running in for the anchorage, immense numbers of sea-horses were seen lying on the ice, huddled together, and, at a distance much resembling a group of cattle. We succeeded in killing several, some of which were of a prodigious size; for instance, one which we cut up was found to weigh twenty hundred weight. These animals are seen every where near the land, on the ice, as well as in the sea; and they are found in the bays (which are numerous all along the coast,) lying on the beach, sometimes to the amount of several hundreds. To the stranger they present the most forbidding and ugly aspect imaginable: when much annoyed by shot, they assemble their forces, and surround the boat, as if determined to retaliate; thirty, forty, or more, will appear in every direction, and almost at the same moment, and so near, that the muzzle of your musket will often reach their heads; they now make a hissing, barking kind of noise, and no sooner receive your fire, than they become apparently furious, roll about, descend probably for a minute, and then re-appear with an immense increase of numbers, and seem bolder in their assaults; several of our oars were snapped in two, or otherwise broken by them, In their upper jaw are two tusks of great size, which seem as if intended by nature to form the principal means of defence, as well against the attacks of their enemies, as to raise and support their huge carcase and then elevate themselves from the sea to the ice; these tusks are often of the purest ivory, and when they have obtained their full growth, are of considerable value: their hides are very thick, and of the toughest texture; but they are coarse, and fit only for placing on the rigging of ships to prevent chafing. When brought on board, their bodies emitted a most intolerable

stench; to get rid of which, as soon as they were skinned, the carcass was thrown over-board. The rein-deer of Spitzbergen do not, I think, differ essentially from the deer of England, except that, as the autumn advances, they begin to cast off their summer coat, and during the winter months become perfectly white; even in the end of June their winter coat was but beginning to fall off, and many of those we killed, were still nearly white. We also saw many white bears, but only succeeded in killing one.

"We continued at anchor in Fair Haven about seven or eight days, during which time we (the two ships) succeeded in killing about forty-five or fifty deer, the weight of each of which averaged at least 120 pounds. We again put to sea, hoping, that as the season was now more advanced, we should be able to penetrate towards the north. Having discovered some partial openings in the ice, we forced our way in; and on this occasion we gained the highest northern latitude we were destined to reach, viz. 80° 32′ N. Here we were again completely surrounded and blocked up, in which state we continued during a period of three weeks; at length, on the 29th of July, after immense labour and fatigue, we succeeded once more in getting into open water, little aware of the catastrophe which was to befal us on the approaching morn. We had gained an offing of eight or ten miles from the packed ice, when, about four o'clock, A.M. on the 30th of July, a dreadful gale of wind came on, blowing directly on the ice; in a few hours we found ourselves in an awful situation, unable to weather the ice on either tack, and drifting fast on the main body of it, which the wind and swell had now rendered, to every appearance, a solid mass. We knew not what to do; there was no time for deliberation; and to prevent the ship from driving broadside on, the only alternative we had was, to put the helm up, and, if possible, to force her head into the ice. A little after nine o'clock, the word was given to put the helm up; an awful pause succeeded; the most solemn dread pervaded every countenance; to all human probability there were but a few moments betwixt us and eternity; and every individual, with the most dreadful anxiety, watched the moment when the ship

should receive the first shock. The concussion was tremendous; the sea was running awfully high, and at the instant of coming in contact with the ice, it threatened every moment to swallow us up. Our ship continued to receive most dreadful shocks; but in the course of half an hour, had forced herself in, probably about two or three times her own length. The immense masses of ice, which now surrounded us in every direction, served, in a great measure, to shield us from the violence of the sea, and we were now so firmly wedged, that the ship comparatively had but little motion.

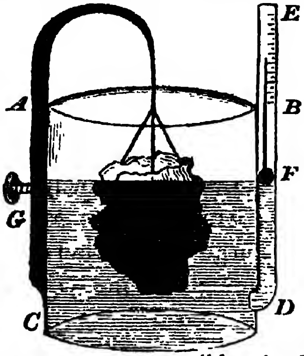
" Fortunately, the gale soon moderated; but we found ourselves in a sinking state; all the pumps going, and unable to keep the ship free. We now expected every moment to go to the bottom: the following morning was providentially fine, and the ice had somewhat separated; with the utmost exertion of every soul on board, we succeeded in getting the ship out of the ice, and were able on the following morning to reach Smeerenberg Harbour, Spitzbergen.

" Our ship being now in such a shattered condition, every idea of wintering was at an end, and it became a question whethe ship (the larboard side in several places being literally stove-in) was sea-worthy? or, if every thing considered, and under all the circumstances, it would be prudent to risk our lives in crossing the Atlantic?

" Having got into Smeerenberg Harbour, it was found we possessed the means of materially strengthening our vessels; after the completion of which, it was determined we should proceed to England."

During their stay in Smeerenberg Harbour, which was about a month, an observatory was erected on Danes Island, about three miles from the ship, where Mr. Fisher took up his residence, and was fortunate enough to get several transits. He ascertained the length of a pendulum vibrating seconds, the longitude of the place, and made observations on the refraction, magnetic dip, variation, its diurnale change, (which appears by his experiments to have a most important connexion with atmospheric pressure,) and upon the electricity of the

atmosphere, he also had several lunar observations, (a possibility of obtaining which must rarely occur there from the state of the atmosphere,) and examined the temperature and specific gravity of the sea-water in every degree of latitude through which they passed, at the surface, and at different depths; also the specific gravity of the different kinds of ice, for which purpose Mr. Fisher contrived the following instrument, of which we believe we shall be able to give a correct account.



It consists nearly of a cylindrical vessel A B C D, having a narrow tube E D, attached to it, and communicating with the interior of the cylinder at D. which being partly filled with water, floated a thin stem B F, on a piece of cork along the graduated surface B E. Now the water being of a known specific gravity, and as low a temperaure as possible, the height of the stem is read off. A piece of ice being put in the water, and the height read off, it is then totally immersed by means of a forked wire pressing on its upper surface, and which is raised and depressed by means of the screw G, by which we get the relation between its weight and magnitude, consequently its specific gravity in terms of the specific gravity of the water; and the difference between the first and third readngs : difference between the first and second readings : specific gravity of the water : specific gravity of the ice..

If the temperature be such as to dissolve a sensible quantity of the ice during the operation, which never need exceed a few seconds, and thereby increase the quantity of water in the cylinder, screw up the fork, and take a fourth reading; then the difference between the fourth and second reading will be equal to that increase, by which the other readings may be corrected.

The Narrative of the Voyage we understand will shortly be published by Mr. Murray, Albemarle-street, written by Captain Buchan and Mr. Fisher, in which the results of the observations will be given.

Art. XII. *A Journal of the Temperature of the Weather, commencing May 14th, 1812, and continued till December 31st, at Sierra Leone. By Mr.* Wilford.

Day of the Month	Time of the day	Height of Therm.	Remarks.
May	6		Cloudy and hazy. A few drops of rain.
14	12	86½	Fresh Sea breeze. Cloudy, but fair.
	6	86	Fine clear evening.
	6	83	Cloudy. Lightning in the night.
15	12	86½	Cloudy, with thick haze
	6	86	Distant lightning in the E. S. E.
	6	79	Slight tornado in the night. Cloudy.
16	12	85	Hazy and fair. Strong sea breeze.
	6	85	Weather as at noon.
	6	78	Tornado in the night.
17	12	85½	Sultry. Cloudy, especially on the mountains.
	6	86	Tornado, with distant thunder to the S. W.
	6	79	Heavy rain without thunder.
18	12	78	Gloomy weather. Cessation of rain.
	6	83½	Calm and cloudy. Distant lightning.
	6	79	Clear, with rising clouds to the N. W.
19	12	86	Cloudy, and clear horizon.
	6	86	Lightning in the N. N. E.
	6	82½	Rain, with N. E. wind.
20	12	85½	Fresh sea-breeze. Black clouds around.
	6	83½	Hazy, with dark clouds.
	6	83	Hazy, with lead coloured sky.
21	12	85	Still overcast. Rain in the mountains.
	6	85	Distant lightning all around.
	6	80	Tornado in the night. Clear.
22	12	85	Clear. [10, a tornado.
	6	85	Thunder and lightning to the E and N. E. at
	6	77	Gloomy. Mountains covered with clouds.
23	12	85	Clear.
	6	85	Lightning to the northward.
	6	79½	Hazy, with heavy clouds on the bottom side.
24			[Clear to the S.
	12	85	Excessively black to the S. westward. Slight
	6	83	Distant thunder. [showers.

Day of the Month	Time of the day	Height of Therm.	Remarks.
May	6	80½	Dense clouds, with distant thunder.
25	12	85	Tornado to the eastward. Gloomy.
	6	81	Lightning to the eastward.
	6	77	Tornado in the night. Cloudy.
26	12	84	Still lowering.
	6	84	Pleasant evening. Moon very pale.
	6	80	Mountains covered with dense clouds.
27	12	83	Some rain. Now gloomy.
	6	72	Thunder, lightning, and torrents of rain.
	6	74	Fair. Dark heavy sky.
28	12	86½	Calm and Cloudy. Sultry.
	6	84	Thick dark clouds.
29	6	80	Fine. Journal interrupted.
June	6	81	Very hazy.
2	12	92	No sea breeze.
	6	81	Tornado in the afternoon.
	6	78½	Clear.
3	12	85½	Rain in the mountains.
	6	84	Serene.
	6	80	Gloomy. Distant thunder.
4	12	85	Still lowering, but no rain.
	6	83½	Fine.
	6	80½	Rain in the mountains.
5	12	81	A heavy shower.
	6	81½	Dark, calm weather.
	6	79	Heavy rain in the night.
6	12	81	Calm, with rain.
	6	81	Calm and cloudy.
	6	79	Rain towards morning.
7	12	84	Drizzling and calm.
	6	83	Lightning, and dark clouds in the N. E.
	6	79	Fair, with lead coloured sky.
8	12	84	Calm and cloudy.
	6	81	Rain in the afternoon, now serene.
	6	80	Rain in the mountains; fair below.
9	16	85	Sultry and calm.
	62	80	Heavy and long continued tornado.
	6	78	Dark sky. Fair.
10	12	86	Clear.
	6	84	Serene night.

Day of the Month	Time of the day	Height of Therm.	Remarks.
June	6	79½	Fine.
11	12	85	Fine.
	6	85	Distant thunder, with showers.
	6	81	Calm and fair Cloudy to the N. westward.
12	12	88	Excessively sultry.
	6	83½	Shower from the S. W. with thunder.
	6	81½	Gloomy, and threatening rain.
13	12	—	
	6	82	Cloudy.
	6	77½	Still threatening rain.
14	12	85	Cloudy and sultry. Distant thunder.
	6	83	Serene evening.
	6	79½	Fine. A tornado in the night.
15	12	84	Fresh sea breeze.
	6	82	Distant thunder and lightning to the eastward.
	6	78½	Heavy tornado in the night.
16	12	83	Strong sea breeze.
	6	84	Distant thunder to the eastward, which approaches.
	6	79½	Long continued tornado early in the night.
17	12	84	Distant thunder. More serene.
	6	81	Rain with thunder, at 3 o'clock.
	6	78	Fine.
18	12	83	Shower of rain without thunder.
	6	80½	Serene night.
	6	77½	Hazy and very damp.
19	12	82	Cloudy. Calm.
	6	80	Rain at 4, with thunder and lightning.
	6	77	Fine.
20	12	82	Fine.
	6	81½	Fleecy clouds floating to and fro.
	6	78	Serene,
21	12	85	Fresh sea-breeze.
	6	81	Heavy tornado.
	6	76½	Pleasant morning.
22	12	84	Sultry.
	6	81	A shower at 4 o'clock. Thunder.
	6	79	Fine.
23	12	—	
	6	80	Rain in the afternoon.
	6	78½	Drizzling rain during the day.
24	12	84	Fine evening.
	6	82	

Day of the Month	Time of the day	Height of Therm.	Remarks.
June 25	6	79½	Gray morning.
	12	81	Heavy rain in the afternoon.
	6	77½	
26	6	75½	One smart shower during the day.
	12	83	
	6	81	
27	6	77	Cloudy, but no rain.
	12	83½	
	6	83	
28	6	80	Sultry in the forenoon.
	12	86	A few drops of rain at 4. Lightning all around.
	6	82	
29	6	79	Tornado last night.
	12	81	Cloudy.
	6	79½	Tornado in the mountains.
30	6	77	Much rain during the day.
	12	80	
	6	79	
July 1	6	78	Fine all day.
	12	84	
	6	82	
2	6	78	Rain at intervals during the day.
	12	82	
	6	80	
3	6	78½	Fine throughout.
	12	82	
	6	82½	
4	6	79½	Dense clouds, with rain at intervals.
	12	80	
	6	79	
5	6	77	Fine clear day throughout.
	12	82	
	6	82	
6	6	78	Drizzling rain most of the day.
	12	80	
	6	80	
7	6	78	Heavy rain at 2 o'clock, without thunder, [from the S. W.
	12	80	
	6	79	
8	6	80	Rain towards evening.
	12	81	
	6	81	

Day of the Month	Time of the day	Height of Therm.	Remarks.
July 9	6 12	81	Rain.
10	6 12	77	Fine.
11	6 6	77 79	Much rain.
	6^{m}	77	Journal interrupted till the 21st.
21	6^{e}	79	Rainy.
22	6 6	76 78	Rain throughout.
23	6 6	76 2	Much small rain without wind.
4	6 12 6	77 83 82	Rain. Fine.
25	6 6	77½ 79	As yesterday.
26	6 6	77 79	Rainy.
27	6 6	77 82	Less rain in the forenoon. Fine evening.
28	6 6	80 80	Fine day throughout.
29	6 6	78 80	Ditto.
30	6 6	77 78	Showery all day.
31	6 6	77 79	Fine throughout.
Aug. 1	6 6	77 77	Showery in the afternoon.
2	6 6	76 75	Constant rain till noon, then showery.
3	6 6	75 80	Fine throughout.
4	6 6	77 81	Serene still day.
5	6 6	78 78	Showery afternon.

Day of the Month	Time of the day	Height of Therm.	Remarks.
Aug. 6	6 6	76 78	As yesterday.
7	6 6	77 80	Showery after sunset.
8	6 6	77 77	Rainy throughout.
9	6 6	76 76	Incessant rain till noon; then showery.
10	6 6	75 77	Fine throughout.
11	6 6	77 78	Slight shower in the afternoon.
12	6 6	77 78½	Heavy shower in the morning.
13	6 6	76 76	Much rain in the afternoon.
14	6 6	76 78½	Fine day.
15	6 6	77 80	Fine day.
16	6 6	75½ 77	Much rain.
17	6 6	75 77	Showery all day.
18	6 6	76 78½.	Drizzling rain.
19	6 6	76 78	Rain from nine till noon.
20	6 6	76 78	Rainy throughout.
21	6 6	76 79	Showery all day. Tornado in the afternoon.
22	6 6	76 80	Thundar and lightning from the Eastward. Rain from the N. E.
23	6 6	75 79	Heavy tornady in the night. Charming day. Sea breeze.
24	6 6	77 80	Fine throughout.
25	6 6	77 70½	As yesterday.

Day of the Month	Time of the day	Height of Therm.	Remarks.
Aug. 26	6 6	77 77	Rainy all the forenoon, and part of the afternoon.
27	6 6	76 80	Showery till noon.
28	6 6	78 80	Cloudy, with a strong sea breeze.
29	6 6	77 76	Strong breeze from the N. W. wirh a heavy swell. Rain in the evening.
30	6 6	76 76	Heavy rain at sunset, and during part of the night.
Sept. 1	6 6	76 80	Fine day.
2	6 6	77 80	As yesterday. Gloomy at night.
3	6 6	76 81	Sultry at noon. Distant lightning to the eastward. No rain.
4	6 6	79 78	Tornado in the afternoon, with a little rain.
5	6 6	77 78	One or two flying showers in the day.
6	6 6	76 78	Heavy rain during the greater part of the day.
7	6 6	76 79	Fine throughout.
8	6 6	78 78	Rainy in the forenoon.
9	6 6	75 78	Drizzling rain till noon.
10	6 6	75 79	Fine throughout.
11	6 6	75 82	Clear. Distant lightning.
12	6 6	77 80	As yesterday.
13	6 6	78 78	Much rain, with distant thunder, towards evening.
14	6 6	76 79	Heavy rain at sunrise. Fine all day.
15	6 6	76 80	A shower in the afternoon.

Day of the Month	Time of the day	Height of Therm.	Remarks.
Sep.	6	79	Pleasant day.
16	6	83	
17	6	71	Tornado in the night.
	6	81	Fine day
18	6	77	Showery.
	6	78	
19	6	76	As yesterday.
	6	80	
20	6	77	
	6		
21	6		
	6	82	Fine.
22	6	77½	Much rain, with thunder.
	6	83	
23	6	76	Very fine.
	6	82	
24	6	75	Tornado in the night.
	6	82	Fine all day.
25	6	75	Tornado in the night.
	6	77	Rain in the afternoon.
26	6	76	Rain at sunrise.
	6	82	
27	6	77	Fine throughout.
	6	82	
28	6	79	Fine morning.
	6	79½	Heavy tornado.
29	6	77	Serene day.
	6	80	
30	6	76	Serene.
	6	84	
Oct.	6	79	Rainy.
1	6	77	Ditto.
2	6	76	Incessant rain all day.
	6	76	
3	6	75	Fine.
	6	80	A shower at 6 P. M.
4	6	76	Shower in the forenoon.
	6	78	

Day of the Month	Time of the day	Height of Therm.	Remarks.
Oct.	6	75½	Fine. Travelling ants appear.
5	6	79	Tornado, but not severe.
6	6	76½	Bright sunshine. Saw a wagtail.
	6	84	Distant thunder.
7	6	76½	Showery, with distant thunder.
	6	79	
8	6	76	Showery.
	6	78	Fine.
9	6	76	Fine all day.
	6	82	
10	6	77	Wet evening.
	6	80	
11	6	75	Fine. A few drops of rain at noon.
	6	82	
12	6	78	Fine.
	6	82	
13	6	76	Tornado in the night.
	6	79	Much rain.
14	6	75½	Much rain in the night. Fine at sun-rise.
	6	81	Fine evening.
15	6	77	Fine day throughout.
	6	83	
16	6	79	Heavy tornado on the Bullom shore.
	6	83½	
17	6	78	A harmattan from the east, in the morning.
	6	82	Fine throughout.
18	6	77½	Fine morning.
	6	80	Clear and fine. Distant thunder.
19	6	73½	Heavy tornado at midnight.
	6	82	Fine day.
20	6	76	Fine throughout.
	6	81	
21	6	77	Tornado in the mountains.
	6	83	Distant lightning to the eastward.
22	6	76½	Shower in the afternoon.
	6	85	
23	6	74	A smart tornado without lightning.
	6	81½	Fine day.
24	6	76	Tornado without lightning.
	6	80	

Day of the Month	Time of the day	Height of Therm.	Remarks.
Oct.	6	75	Fine.
25	6	81	Rain.
26	6	75	Fine.
	6	82	Rain.
27	6	77	Heavy rain in the afternoon.
	6	81	
28	6	75	Tornado in the night.
	6	82	Fine.
29	6	76	Fine day. Lightning in the E. N. E.
	6	82	
30	6	74½	Fine. Lightning in the N. E.
	6	83	
31	6	76	Fine all day.
	6	83	
Nov.	6	77	Vivid lightning and distant thunder to the eastward.
1	6	84	Rain. Violent and long continued tornado at 9 P. M.
2	6	76	
	6	82	Vivid lightning on the Bullom shore.
3	6	76	Tornado at 10 P. M. from the E. N. E.
	6	84	Very distant lightning from N. E.
4	6	76	Tornado in the night, with much rain.
	6	82	Lightning, with distant thunder.
5	6	77¼	Fine all day.
	6	79	
6	6	77	As yesterday.
	6	81	
7	6	77	Fine throughout.
	6	83	
8	6	75	Fine.
	6	80	Tornado.
9	6	77	Tornado.
	6	84	
10	6	77	Fine.
	6	80	No lightning. Very fine.
11	6	77	
	6	77	Rain with distant thunder.
12	6	74½	Stormy night.
	6	78	Cloudy.

Day of the Month	Time of the day	Height of Therm.	Remarks.
Nov.	6	76	Fine.
13	6	80	Fine.
14	6	75	Tornado towards morning.
	6	80	Tornado at 11 P. M.
15	6	75	Tornado at 4 P. M.
	6	76	
16	6	75	Fine throughout.
	6	80	
17	6	75½	Tornado towards morning.
	6	80	Fine day.
18	6	78	
	6	80	Distant tornado towards sunset.
19	6	78	Distant tornado in the afternoon.
	6	79½	
20	6	78	Heavy rain towards sunset.
	6	78	
21	6	75	
	6	78½	Fine.
22	6	78	
	6	79	Tornado after sunset.
23	6	76	Fine day.
	6	82	
24	6	78	Fine day.
	6	80	
25	6	77	Clear day.
	6	84	Heavy tornado.
25	6	75	Fine day.
	6	81½	
27	6	76½	Heavy tornado in the night.
	6	82	
28	6	77½	Fine.
	6	82	
29	6	77½	Fine.
	6	84	
30	6	79	Fine.
	6	80	
Dec.	6	79	Fine.
1	6	80	Ditto. Thermometer 90° at 4 P. M.
2	6	79	Bright day
	6	80	

Day of the Month	Time of the day	Height of Therm.	Remarks.
Dec.		81	Hazy all day.
3	0	79	
4	6	74½	Fine.
	6	81	
5	6	78	Fine.
	6	80	
6	6	78	
	6	82	Fine. Therm. 90° at 3 P. M.
7	6	77	Hazy at sun rise
	6	81	
8	6	76	Hazy and dark to the eastward.
	6	79	
9	6	76	As yesterday.
	6	80	
10	6	78	Fine.
	6	83	
11	6	77½	
	6	82	
12	6	78	
	6	79	
13	6	78	
	6	81	
14	6	77½	
	6	82	
15	6	76	
	6	81	
16	6	78	
	6	80	
17	6	75½	East wind, or harmattan.
	6	79	
18	6	77	No sea breeze.
	6	79	
19	6	74½	Harmattan continues.
	6	81	
20	6	76	Sea breeze.
	6	78	
21	6	79	Fine.
	6	80	
22	6	76	
	6	80	

Day of the Month	Time of the day	Height of Therm.	Remarks.
Dec. 23	6 6	77 80	
24	6 6	77 81	
25	6 6	77½ 80	
26	6 6	80 81	
27	6 6	77 79	
28	6 6	76 80	
29	6 6	80 80	Mountains covered with clouds.
30	6 6	78 78	Strong sea breeze.
31	6 6	77½ 78½	

Art. XIII. *On the Separation of Lime and Magnesia.* *By* Richard Phillips, *Esq. F. L. S., M. of Geol. Soc.*

In the Annals of Philosophy for November last, Dr. Thomson has justly observed, that "In analytical chemistry, it is a problem of considerable importance, to separate magnesia from lime when they happen to exist together in the same mineral, as, for example, in magnesian limestone." I had before, observing this remark, paid some attention to the subject; and I have tried most of the methods which have been proposed, the results of which, as well as of one which I believe to be new, I now send you.

The first and most obvious method is, that of attempting to separate the lime from the magnesia, because it forms compounds of less solubility; to effect this, oxalate of ammonia has been used, but to the employment of this there are several objections. When a solution of oxalate of ammonia is added to one of muriate of lime and magnesia, no effect is at first produced, although there may be much lime dis-

solved, if the magnesia be in considerable quantity: eventually, however, and without the assistance of heat, precipitation takes place; but it appears to me, that the whole of the lime is not precipitated until sufficient oxalate of ammonia has been added to form with the muriate of magnesia a double salt. This tendency of magnesia to form compounds with ammonia is indeed so strong, that when the magnesia greatly exceeds the lime in quantity, oxalate of ammonia added in small proportion, combines altogether with the magnesian salt; nor will ebullition effect the separation of any oxalate of lime.

In order to obviate the effects produced by the ammoniacal oxalate, I employed oxalate of potash; the use of this is, however, attended with another difficulty.

Magnesia has a powerful affinity for oxalic acid, and they form a compound of difficult solubility in water; when, indeed, lime water is added to a saturated solution of oxalate of magnesia, in equal quantities, the lime water, although containing so small a quantity of lime in solution, not only causes the instant precipitation of magnesia and oxalate of lime, but the solution retains, after this, sufficient lime to redden turmeric paper.

It is then evident, that a solution of oxalate of magnesia, even when saturated, contains but very little of the salt, since so weak an alcaline solution as lime water, is more than sufficient to decompose an equal quantity of it.

When oxalate of potash is added to a solution of muriate of magnesia, no effect is for a few seconds produced; but in a short time oxalate of magnesia is precipitated, and this effect is much accelerated by heat. For these reasons, I consider the employment of an oxalate as inaccurate; it forms either a double salt with magnesia when oxalate of ammonia is used; and when oxalate of potash is employed, it precipitates the magnesia as well as the lime.

Magnesia, when added to oxalate of ammonia, immediately decomposes it, giving out ammonia; and when it is added to a solution of oxalate of potash, it has sufficient affinity for a part, at least, of the oxalic acid, to take it from the potash, so that the filtered solution is strongly alkaline.

Dr. Wollaston has suggested a method of separating these

earthy substances, which I state, with much deference, appears to me to be liable to objection; I do not know whether the process has been published, except by Dr. Marcet, in his analysis of the Brighton chalybeate water.

In this analysis, the process is stated to consist in adding a solution of fully saturated carbonate of ammonia to that of the mixed earths, by which it is conceived that lime is precipitated, and the magnesia held in solution, and afterward precipitated by phosphate of soda. Now, I find, even when what is usually called subcarbonate of ammonia is made use of, that a portion of the lime is held in solution; this may be seen by adding solution of subcarbonate of ammonia to one of pure muriate of lime; after the precipitate has been separated by the filter, ammonia poured into the clear solution, causes a deposition of carbonate of lime. It appears then to me, that a portion of the lime must be precipitated with the magnesia in the state of phosphate.

In the Journal of Science and the Arts, (Vol. III. p. 217,) it is correctly observed, that as lime is soluble to a certain extent in bicarbonate of potash, this salt cannot be employed to separate the lime, and hold the magnesia in solution; but, it is stated, that M. Doebereiner "suggests the subcarbonate of ammonia as the best re-agent in such cases. The carbonate of lime is precipitated, and the magnesia remains in solution, forming a triple compound with ammonia, from which the earth may be easily separated by ebullition." It is added, that "M. Vauquelin has been in the habit of recommending the same process for many years." I am again compelled to differ from high authority as to the correctness of the mode proposed in this case; for it follows, from what I have already stated, that a portion of the lime is held in solution.

As a modification of this method, I attempted to discover, whether if the two earths were precipitated together by carbonate of soda, a solution of carbonate of ammonia would separate them.

I found that it readily dissolved carbonate of magnesia so obtained; and, as a preliminary experiment, I precipitated some carbonate of lime without any admixture of magnesia,

and then digested it, without heat, in a solution of carbonate of ammonia; but when ammonia was added to the filtered solution, it was evident that carbonate of lime had been dissolved, for precipitates immediately occurred.

It is also mentioned in the communication just quoted, that when the mixed carbonates of lime and magnesia, are boiled in a solution of muriate of ammonia, that the magnesia only is dissolved; the fact however is that the lime is also taken up, for ammonia is plentifully evolved when carbonate of lime only is employed, as is indicated not only by turmeric paper, but readily detected by the smell.

In the Number of the Annals of Philosophy already alluded to, Dr. Thomson proposes a method, which is probably more accurate than any hitherto suggested.. This consists in dissolving the mixture of lime and magnesia in muriatic acid or nitric acid; then adding to the solution a quantity of sulphuric acid capable of saturating both the earths; the mixture is then to be evaporated to dryness, and exposed to sufficient heat to expel the excess of acid. The dry mass is digested in water, and a little alcohol is poured into the solution, to diminish the solubility of the sulphate.

It is evident, that the only source of error in this plan is derived from the solubility of the sulphate of lime, and even this Dr. Thomson proposes to remedy, either by repeatedly crystallizing the sulphate of magnesia, or by separating the lime with oxalic acid. I submit, however, that the first of these methods would be tedious; and if oxalic acid could at all be employed for the purpose of separation, it might as well be used in the first instance.

In attempting to find some unexceptionable method of effecting the separation of these earths, I tried to discover some substance which should precipitate the lime from its solution in muriatic or nitric acid, to avoid the trouble of converting both earths into sulphates.

In this, however, I failed; at one time I thought that phosphate of soda would precipitate all the lime, and leave the magnesia in solution; I found, however, that phosphate of lime is sufficiently soluble in water to give a precipitate with oxalate of ammonia; and that phosphate of magnesia, though

much more soluble, was not sufficiently so to answer the purpose with correctness.

The plan which, after many trials, I venture to propose, is this;—to the muriatic or nitric solution of lime and magnesia, add sulphate of ammonia in sufficient quantity, evaporate the mixture gradually to dryness, and then heat it to redness till it ceases to lose weight, by the volatilization of the muriate or nitrate of ammonia formed. Note the weight of the mixed salt, reduce it to powder, and wash it with a saturated solution of sulphate of lime, till all the sulphate of magnesia appears to be dissolved; dry the sulphate of lime left, and by deducting its weight from that of the mixed sulphates, the quantity of sulphate of magnesia dissolved will appear.

I prefer sulphate of ammonia to sulphuric acid, because the operation is not only less disagreeable, but the contents of the crucible are not so subject to spirt out of it, and occasion loss.

If it be required to verify the experiment, by ascertaining the quantity of sulphate of magnesia dissolved, this may be effected by two modes; first, by noting the quantity of solution of sulphate of lime employed, and ascertaining how much carbonate of lime a similar quantity of it yields by carbonate of soda; all excess of weight obtained by similar means from the solution employed, will, of course, be owing to carbonate of magnesia, and by this the quantity of sulphate dissolved may be discovered.

Secondly, the quantity of sulphate of magnesia dissolved, may be known by comparing the quantities of sulphate of barytes obtainable from the pure solution of sulphate of lime, and from that of the two sulphates.

In order to shew whether this method may be relied upon with any degree of confidence, I added one grain of sulphate of lime to about four ounces of a mixed solution of sulphate of magnesia and sulphate of lime; not a particle appeared to be dissolved, the sulphate readily subsiding, whereas, a similar quantity of solution of sulphate of magnesia appeared to dissolve the sulphate of lime, as readily as if no sulphate of magnesia had been present.

Art. XIV. *On the Acid formed by the slow Combustion of Ether. By* J. F. Daniell, *Esq. F. R. S. and M. R. I.*

Section I.—*Preparation and Properties of the Acid.*

Sir Humphry Davy, during his researches on the nature and properties of flame, announced the singular fact, that combustible bodies might be made to combine with oxygen, at temperatures below what were necessary to their inflammation. Amongst the phenomena resulting from these new combinations, he remarked the production of a peculiar acid and pungent vapour from the slow combustion of ether; and from its obvious qualities, he was led to suspect, that it might be a product yet new to the chemical catalogue. Mr. Faraday, in the Journal of the Royal Institution, has given some account of the properties of this new acid; but, from the very small quantities in which he was able to collect it, was prevented from performing any decisive experiments upon it.

As soon as Sir Humphry Davy's discovery had been applied to keeping a platinum wire in a state of ignition by means of a lamp with spirit of wine, it occurred to me, that the contrivance might be adapted to the production of the new compound in larger quantities. I immediately set about the experiment, and found it to succeed perfectly. The apparatus which I made use of was the head of an alembic, properly supported, to the beak of which I applied a receiver, and under its larger opening placed a small lamp, properly trimmed with a coil of platinum wire. In this way I could collect with ease the vapours of any inflammable substance with which the lamp was charged. Some little nicety is requisite both in trimming the lamp, and in placing it afterwards, to insure its most advantageous effects; but this is soon learned from practice. Too much of the cotton must not be left exposed, or much of the liquid evaporates unchanged, and adulterates the product; and the lamp must not be placed too high in the alembic, or it becomes extinguished, nor too low, or the vapours are dissipated. With proper precautions, I have kept a lamp glowing for six weeks together.

The first vapours which I collected were those from spirits of wine. The condensed liquid was slightly acid, and possessed a rather pleasant, pungent smell. It proved in the sequel to be the same acid as that produced from ether, largely diluted with water and spirits of wine.

From spirits of turpentine I obtained a liquid of a light amber colour, and very agreeable odour, which, by the evaporation of the superfluous spirit, afforded a solid resin of a deep amber colour, and very fragrant smell, not in the least mixed with that of turpentine. It was inflammable, and burnt with the deposition of much charcoal. It was also soluble in spirits of wine, from whence it was precipitated in a white state, by the affusion of water. This experiment adds much to the plausibility of the theory, which supposes resin to be a volatile oil, deprived of a portion of its hydrogen, and combined with oxygen.

I attempted in various ways to obtain the products of camphor, but did not perfectly succeed. I first laid the coil of wire red hot upon a mass, where it continued to glow for a long time, till it sunk, and was extinguished. So much of the camphor was sublimed, that it was hardly possible to detect any new combination. There were, however, I think, evident traces of the formation of a resinous body. I endeavoured next to effect my purpose, by charging the lamp with a saturated solution of camphor in spirit of wine. The mixture burned well, but I obtained nothing but the same acid liquor that was afforded by pure spirits of wine, only holding a portion of camphor and some resin in solution.

But it is of the product of the slow combustion of ether that I mean particularly to treat in this Paper. I collected above a pint and a half of the condensed vapour, by the means above described, and, from my experiments, I think I shall be able to prove, that it consisted principally of a new acid, possessed of curious, novel, and interesting properties.

Before I proceed further, it will much facilitate the subsequent details to confer a name upon the newly discovered compound. After much consideration, it is but with dif-

fidence that I venture to propose for it the appellation of *Lampic acid.* My reasons for this choice are briefly these: 1st. It will recall to mind at once its mode of formation and its connection with that brilliant chain of investigation, which is the boast of science and the triumph of humanity. 2dly. It is pledged to no hypothetical views of its composition, or of that of acids in general. A negative recommendation, which it may be thought in the sequel particularly to deserve. 3dly. It will not offend against the euphony of any modern language, while its derivation may be found, by those who wish it, in the English language, and by those who prefer a more learned origin, in the Greek.

The Lampic acid then, as it is at first collected in the manner described, is a colourless fluid, of an intensely sour taste and pungent odour. Its vapour, when heated, is extremely irritating and disagreeable, and when received into the lungs, produces an oppression at the chest very much resembling the effect of chlorine. Its specific gravity varies according to the care with which it has been prepared, from under 1000 to 1008. It may be purified by careful evaporation; and it is worthy of remark, that the vapour which rises from it is that of alcohol, with which it is slightly contaminated, and not of ether. Thus rectified, its specific gravity is 1015. It reddens vegetable blues, and decomposes all the earthy and alkaline carbonates.

SECTION II. *Of the Combinations of the Lampic Acid.*

Mr. Faraday, in his paper, asserts that this acid has no action on the carbonate of lime, even when newly precipitated; but he must have been deceived by the smallness of the quantity, and the weakness of the acid which he employed. It dissolves it rapidly with effervescence. It forms neutral salts with the alkalies and earths, all of which are more or less deliquescent.

259.2 grs. of the acid of the specific gravity of 1013.9, dissolved 36.2 grs. of bicarbonate of soda. The loss of weight from the carbonic acid given off was 19.3 grs. The weight

of *lampate of soda* carefully evaporated to dryness, and taken while still warm, was 35.4 grs. From these data, the composition of the salt upon Dr. Wollaston's scale, is

22	Acid	62.1
13.4	Soda	37.9
35.4		100

516.8 grs. of the acid dissolved 54.9 grs. of carbonate of barytes; 71.3 grs. of *lampate of barytes* were produced. By the same scale the composition of this salt is therefore

28.1	Acid	39.5
43.2	Barytes	60.5
71.3		100

9.2 grs. of lampate of barytes dissolved in distilled water, and precipitated by sulphuric acid, yielded 8.4 grs. of sulphate of barytes, which also gives the composition of the salt,

3.7	Acid	40.2
5.5	Barytes	59.8
9.2		100

The results of these three analyses fix the number of the lampic acid on the scale of equivalents at about 64.

Lampate of soda is a very deliquescent salt of a not unpleasant saline taste. It is not easily made to crystallize, and is speedily decomposed by heat. 34 grs. of it absorbed 14 grs. of moisture from the atmosphere in 24 hours.

Lampate of potash is hardly to be distinguished by its taste from lampate of soda. It is not quite so deliquescent, but is not easily obtained in crystals.

Lampate of ammonia is a volatile salt, which evaporates at a temperature below that of boiling water, and produces a very disagreeable smell, like that of burning animal matter. It is always of a brown colour, even when prepared with the greatest care, and formed by the solution of carbonate of ammonia in cold acid.

Lampate of barytes crystallizes readily in colourless transpa-

rent needles. Although not so deliquescent as the former salts, it absorbs moisture from the air, and is very readily soluble in water.

Lampate of lime is very deliquescent, and possesses a very caustic, bitter taste, although perfectly neutral.

Lampate of magnesia has a sweetish, astringent taste, not unlike that of sulphate of iron.

All these salts take fire, and burn with flame; and when their gaseous matter is consumed, continue to glow like a coal, from the quantity of carbon which they contain.

But the most curious and distinguishing characters of the lampic acid arise from its action upon the metallic oxides.

Lampate of gold.—If some of it be poured into a solution of muriate of gold, in a few hours time the metal is precipitated in the metallic form, and a thin film of gold attaches itself to the glass in which the experiment is performed. If the mixture be heated, the reduction is almost instantaneous. The lampates of potash and ammonia both throw down a light yellow precipitate from the same solution, which a very slight degree of heat is sufficient to decompose, a beautiful precipitation of the metal taking place. I have several times performed the experiment in a test-tube, the interior of which has become completely gilt. The light which is transmitted through the thin film, is of the most beautiful purple colour. The process is interesting, and very pretty.

Lampate of platinum.—Muriate of platinum has its colour very much heightened by the addition of a portion of the acid, but it is not reduced. Lampate of potash and lampate of ammonia both throw down from it a yellow and very crystalline salt, which are not reduced separately by a boiling heat; but if the two be mixed together, an instantaneous precipitation takes place, which lines the tube with a coating of metallic platinum. The liquid immediately becomes perfectly colourless, and the metal is of such a consistence as easily to be detached in thin laminæ. It is very dark and brilliant, and transmits no light.

Lampate of silver.—Nitrate of silver is immediately affected

by the acid. A precipitation takes place, which is at first of a purplish brown colour; this arises from the effect of the metallic particles upon the rays of light. Part of the metal lines the tube, and part accumulates in a powder at the bottom, and is easily fused into a button by a blow-pipe.

The oxide of silver is dissolved by the lampic acid, and the solution is of a sea-green colour. A heat, under that of ebullition, decomposes it, and precipitates the metal.

Lampate of mercury.—Nitrate of mercury in solution, and warmed, exhibits a very beautiful phenomenon when mixed with the acid, A metallic shower takes place, and brilliant globules of mercury soon accumulate at the bottom of the vessel.

The red oxide of mercury is readily acted upon by it. A bulky white salt results, which is very sparingly soluble in water; when dried upon blotting paper, and laid by for a few days, it is spontaneously decomposed, and globules of the metal are produced. I put a considerable quantity of lampate of mercury into a retort, adapted a receiver to it, and heated it strongly; a violent effervescence took place; metallic globules immediately began to collect, but some dense fumes were given off; these condensed in the receiver into a liquid, of apparently very considerable specific gravity; it was intensely sour, and of a most suffocating odour, something resembling that of sulphurous acid. It was pure lampic acid; but the mutual decomposition of the acid and the oxide of mercury in the retort was so extremely rapid, that I could collect but a very small quantity of it.

Being desirous of ascertaining what was the nature of this decomposition of the metallic oxides, I put some very pure black oxide of manganese into a gas-bottle, with a long neck, and poured some of the acid upon it; the mouth of the vessel I immersed in lime water; a rapid effervescence took place, and carbonate of lime was precipitated in abundance

Lampate of copper.—Lampic acid readily dissolves the black oxide of copper. The solution is of a beautiful blue colour, and by very gentle evaporation in the vacuum of an air-pump,

affords blue rhomboidal crystals; if the solution be boiled, the metal is precipitated of a deep red colour.

Neither the acid nor its salts appear to have any action upon the oxide or salts of *tin.*

The oxide of *nickel* is not acted upon.

Lampate of lead.—The red oxide of lead is dissolved readily. A white and easily-crystallizable salt is formed, of a sweetish taste; it is not so soon decomposed as the other metallic salts, but burns with flame, and glows like a live coal.

Lampate of iron.—The red oxide of iron is not acted upon, nor has the acid any effect upon the sulphate or nitrate of that metal. The lampates, however, of potash and ammonia separately, turn the nitrate of iron to a beautiful blood-red colour, without precipitate, and jointly throw down the red oxide.

Concentrated sulphuric acid instantly blackens the lampic acid, and disengages a very large quantity of carbon: the nitric acid acts upon it with the extrication of nitrous gas, and forms oxalic acid.

Section III.—*Analysis of the Lampic Acid.*

I next attempted to analyze this new acid by means of some of its compounds. For this purpose, I selected the lampate of barytes as the most proper. I mixed some of this salt with six times its weight of chlorate of potash, and placed it in a platinum tube, to which I had adapted an apparatus to pass the products over dry muriate of lime, and to collect them over mercury.

I had not, however, long applied heat, before an explosion took place, which rent the tube with the report like that of a musket (although the platinum was one-eighth of an inch thick,) and scattered the apparatus to different parts of the laboratory. I then prepared an apparatus similar to that with which MM. Gay Lussac and Thenard effected their analyses of vegetable bodies. I performed the experiment several times, with such additional precautions as each repetition suggested. I shall relate the particulars of the most successful, as I have reason to believe that it is the first time that the apparatus

has been employed in analysis in this country. I found it necessary to have an iron case made for the lower half of the glass tube, as without this, although very thick, and not violently heated, it was blown out into a thin bulb, and generally burst. The fused chlorate of potash which I made use of was analyzed, and was found to yield for every 100 grains, 114.37 cubic inches of oxygen. Lampate of barytes was mixed with this salt, in the proportion of one-sixth of the former to five-sixths of the latter; they were carefully levigated together; and in the course of the experiment, it was ascertained that equal weights yielded equal volumes of gas. 43,8 grains was the total weight of the mixed salts decomposed, 7.5* grains having been first used to expel the common air from the tube. The gas produced from the decomposition amounted to 38.76 cubic inches, to which must be added, 0.98 cubic inches, the proportional quantity of carbonic acid, afterwards expelled by muriatic acid from the residual barytes. 18.13 cubic inches of the gas became over a solution of potash 15.5 cubic inches, which gives 8.12 cubic inches for the total quantity of carbonic acid afforded by the gas; to this also must be added the 0.98 furnished by the residual barytes, making in all 9.1 cubic inches of carbonic acid. The remaining gas proved, upon examination, to be pure oxygen. The quantity of oxygen which would have been given off by the weight of chlorate of potash employed, is 43.74 cubic inches; so that there was a deficiency upon the whole of 4. cubic inches; all the volumes were calculated for mean pressure and temperature. From these data, we may calculate the composition of the lampic acid as follows:

---

* M. Thenard, in the fourth volume of his Traité de Chimie, p. 184, says, that it is of no use to weigh the balls which are dropped in for this purpose; but this must be an oversight, as it is necessary afterwards, in estimating the quantity of carbonic acid expelled from the barytes, to deduct the quantity afforded by these first balls.

40.7	carbon.
7.7	hydrogen.
51.6	oxygen and hydrogen, in the proportions which form water.
100.	

These numbers correspond very nearly with what we may suppose to be the atomic composition of the acid:

1 atom of carbon	37.5	
1 atom of hydrogen	6.5	
1 atom of water	6.5	1 hydrogen
	49.5	1 oxygen.
	100.0	

The carbon and the hydrogen, it will be observed, correspond almost exactly in proportion, while the difference exists chiefly in the water, the calculation for which is certainly the most imperfect part of the French process. All the experiments which I made agreed in making the hydrogen in excess.

The composition of the acid as thus laid down, agrees also most perfectly with the phenomena above described, and explains, in a beautiful manner, the reduction of the metallic oxides.

In another point of view it is also particularly interesting, as affording an exception to the general rule laid down by the French chemists, that in all vegetable acids, the oxygen which they contain is to the hydrogen in a proportion greater than is necessary to form water.

In conclusion, I shall suggest, that the singular property of the lampic acid and its salts of precipitating the metals, may, at some future period, be usefully applied in the arts to plate delicate works with gold and platinum.

Art. XV. *On the Ægina Marbles. By* C. R. Cockerell, *Esq.*

None of the modern discoveries of Grecian sculpture can be regarded as more extraordinary, or more interesting and important to the history of art, than that of the statues which adorned the east and west pediments of the Temple of Jupiter Panhellenius, in the island of Ægina; the only two which are of equal consideration, the discovery of the Niobe and her Children, in Rome, in 1583, and more recently, of the Muses, in the Villa Adriana, occurred at periods more favourable to the study and practice of the fine arts: the political events of late years have occupied all minds, and few opportunities have offered of calling the public attention to subjects of this kind.

The groupe of the Niobe, the Muses, and indeed almost all the known remains of ancient statuary, have been found transplanted from their native soil; often abused and misplaced by their Roman possessors; and again, in the restorations of modern hands, they are generally represented to us in positions and circumstances still more foreign to the intention of their authors. The opinions* of the most learned antiquaries coincide in the belief, that we had not, till within a few years, a single Greek statue of ascertained originality; and that we are acquainted with the translations only of works, the sublimity of which is but faintly conveyed to us by the copies in our possession; the marbles of the Parthenon alone can be excepted, as the undoubted works of Phidias and his scholars.

But although we have not, as in the case of the Athenian marbles, the evidence of history for the names and æra of those who executed the statues of Ægina, yet there can exist no doubt of their originality, from the circumstances of their discovery; and we may fairly surmise, that the most celebrated temple of the island, and one of the most ancient and esteemed

---

* See Winckelman, monum. ined. Mengs, Quatremere de Quincy, and others.

of Greece, would be decorated with the best works of the most approved masters of the time. Overlooked by the rapacious conquerors of Greece, and concealed since the ruin of the temple amongst the fragments of its architecture, they have a value superior to most other discoveries, from their identity with the school of this island, and the certainty which we possess of their original situation and design. As they had been secured from injury by the ruins of the temple, since the accident (probably an earthquake) by which it was destroyed, many of those marbles were found in a perfect state, accompanied with the corresponding portions of the pediment, and so nearly under their former positions as to facilitate the establishment of their original intention and composition, with little doubt of its exactness.

The history of the art derives two essential advantages from these statues; the one as they supply what has long been a desideratum; the most complete example of the school of Ægina; a style much spoken of by the authors* of antiquity, as of very early celebrity in Greece, and at all times held in very high estimation. The number and excellence of the masters of this school in the 6th and 5th centuries B. C. were very great, and we have the names of Callon, Simon, Anaxagoras, Onatas, Glaucias, &c. who filled Greece with their works; and there is scarcely a city described by Pausanias which did not contain some of them.

And though their characteristics have been frequently the subjects of inquiry amongst antiquaries; and that their style has been described by the *ομμασι μεμυκαῖοισ* of Diod: Sic: (lib. i. 97.) the *ορθοσ-αρχαια ξοανα* of Strabo, (lib. 14, p. 146) and in several passages of Pausanias; and has been supposed applicable to various sculptures of an early date, yet no ancient statues have as yet been handed down to us, as undoubtedly Æginetan, or as belonging to any other of the most ancient schools of sculpture. To the specimens which we already

---

* Pliny, lib. 35. cap. 11, and Quintil. Inst. lib. 12, cap. 10. Paus. lib. 7, cap. 4-5. lib. 8. cap. 55. lib. 10. c. 36. lib. 2. c. 29.

possess, illustrative of the later history of the art, these examples of its first celebrated efforts are now added, and the deficiency hitherto regretted, is thus supplied by what may be deemed with great probability, among the best productions of their time. A new field is thus opened to the antiquary, and the progressive history of the fine arts in Greece is traced with more precision.

But what may be considered of still greater interest, and that which renders the discovery of the first importance to architecture, as well as to archæology is, that they afford us a complete example of the great historical compositions of entire statuary, with which the Greeks enriched the pediments of their temples—a species of representation hitherto unknown to us, and which far exceeds in scale and splendor of effect, any which the moderns have attempted—for the greatest efforts of art hitherto employed, in the grand pictures (the stilo machinoso) of the Italians, cannot vie with compositions of this nature, any more than the materials by which either were effected, can be compared together.

The marbles of the Parthenon first conveyed to us a knowledge of this practice among the Greeks; the novelty of entire statues in this situation, and the perfect finish given to the parts never seen by the spectator, were calculated to excite wonder, and to animate further inquiry: some have supposed it to have been the effect of religious devotion; but it is rather to be attributed to the nature of a perfect work, the author of which, aiming at excellence, was not restrained by the ordinary economy of time and labor, and whose desire of self approbation kept pace with his love of glory. The statues of Ægina were equally finished in every part, and we observe the same care in those of the Niobe, which in all probability ornamented likewise the pediment of a temple. From the marks on the cornice in the pediment of the temple of Theseus, and in other examples, this practice appears to have been general.

The statues and fragments of the Parthenon in our possession, are sufficient to give us some notion of the magnificence of these decorations; but it is almost in vain to hope, in that

instance, for any complete restoration of the grouping of the figures, or of the manner of exhibiting the subject. We cannot too much regret the unskilfulness or haste of the artist of the Marquis of Nointel, who with more diligence might still have transmitted what we lament the more, as it has but lately escaped us; for though his drawings supply the number and relative situation of most of the statues, they give very little of their attitude, and still less of their relative scale or character can be understood from them.

The Æginetan marbles are unique in this respect; that those of the western pediment are entire; the exact groupe, and what may be termed the frame of this great picture, with each member and detail of its cornice, is preserved to us.

By this fortunate circumstance, one perfect example of this kind of representation is transmitted to us; its frequency in Greek temples is established; a more extended scale is given to invention, and fresh sources of admiration arise to the student of Grecian art.

The Romans do not appear to have adopted this practice from the Greeks; for we find no example of corresponding depth in the pediments of their temples, nor does any mention of them occur in their authors. In the Pantheon it is very easy to trace the cramps by which a bas relief, supposed to have been in bronze, was attached; but it could only have had a very low comparative relief: in other parts of Italy, there are also some examples of this, and in Rome, there are various ancient bas reliefs of temples, representing their frontispieces; which support the same opinion.

Attachment to customs of their own, want of skill, or the difficulty of accommodating proportionate statues to the ungracefully high elevation of the Roman pediments, may have contributed to prevent, or to interrupt a practice, the advantages of which they seemed to have overlooked.

In the ignorance of a purer source of architecture, the Roman usage has been adopted by the modern schools, and hitherto no other idea has prevailed, than of an embossed pediment, more or less enriched: but in this species of bas relief, the objects are indistinct and confused, and no good

effect has ever been attained, it has sunk therefore into a subject of mere ordinary decoration, and consequently into disrepute.

The superior merits of the Greek practice are sufficiently evident, for when distinction and interest are given to each individual statue, the groupe acquires consistency and meaning: the spectator at each movement, discovers new forms and varieties in the action; and new beauties appear as the light and shades change with the hour of the day. These are the advantages, added to the superiority of sculpture at all times, which this peculiar species of representation bears over painting. In fact it is difficult to feel satiety in viewing a picture three sides of which, each exposing a variety of new charms to the eye, are, as it were, presented to the spectator.

Those who have admired the Laocoon, and have witnessed the effect produced by statues thus composed and connected, will easily imagine that of works on a more extended scale; to the pleasure excited by the forms, and expressions of the figures, is added the surprise at their combination and execution; the mind feels a deeper interest, and a stronger excitement, at the same time that the sight is gratified; and in this last respect, the details which I shall hereafter give of the statues of Ægina, show them to be possessed of extraordinary merit and power.

As a partaker in this discovery, I have been a constant observer and admirer of them from the moment of their excavation until they were nearly out of the hands of Mr. Thorwaldson at Rome; they had been conveyed to that city by their present proprietor, the Prince Royal of Bavaria, and in uniting the broken fragments, and restoring the few parts of them that were deficient, that eminent artist has shewn the greatest care and sagacity.

It may be proper to add, that during the progress of our discovery, I noted with as much accuracy as the case would admit, every circumstance illustrative of their original position, with relation to the architecture of the temple; and I considered each stone and fragment, as the earth was removed from them, in reference to, and in search of some clue

for the restoration of the groupe. Since that period, I have frequently occupied myself with a subject to me of the highest interest; and availing myself at Rome of Mr. Thorwaldson's operations for my last studies of them, I at length succeeded in placing them conformably in all respects to the notes which I had taken on the spot, and consistent with the dimensions of the architecture. It was then highly satisfactory to me, that the mode in which I had recomposed the groups met with the general approbation of those who could compare my drawings with the originals at Rome.

It will be evident to those who have the opportunity of examining what has been done in this respect, that by the inclination of the pediment, of which the fragments afforded ample admeasurements, and by attention to the situations in which the statues were found, much is precisely ascertained, and the position of the greater part of the figures is unavoidably fixed. The Minerva found under the centre must, from her superior height, have occupied the middle of the tympanum; it could not be doubted, that the recumbent heroes were placed in the angles, under which they were found; and the same rule applies to the two principal combatants near the centre of the picture. The situation of the other four combatants is less certain, though their respective dimensions show sufficiently where they must have been placed. Great ingenuity has been shown in the contrivance of the attitude in which the beautiful figure of the fallen hero in the centre lies at the feet of the Minerva, his right leg being bent, leaves room for those of the goddess, whose feet have an oblique position, to accommodate this arrangement; the right arm and shield of the hero are shortened, in order to admit the drapery suspended from the arm of the Minerva. I should add, that every part of the architecture and decoration of painting shown in the accompanying plates, was ascertained from exact admeasurements and observations on the spot. Considerable portions of the acroteria were found at the angles of the temple; that of the apex was found entire in the west; and the feet of the small female statues on either side, were attached to the pedestal on which they stand.

Although the small scale of the accompanying sketches can convey but an insufficient idea of the details of the several statues, the groupe in general may be well understood. The beauty and ingenuity with which so many animated figures are placed in a contracted space, without the smallest appearance of constraint, cannot be sufficiently admired. The difficulty of adapting to a regular mathematical figure, such as the pediment of a temple, a composition of statues, which should at once be picturesque and symmetrical, is overcome with singular success. The formality necessary in architecture is maintained, whilst the several figures in perfect equilibrium, in point of mass and general attitude, have each their distinctive form and character. The eye traces through the whole a delightful variety, at the same time that nothing disturbs the tranquillity of the architecture. With much action in the figures, there is a majesty of order that impresses, while it pleases. There is a fine contrast in the attitudes of the bodies, and the crossing of the different limbs; and there is a link through the whole which connects the picture. The subject, too, as to its general meaning, is obvious, and each tends to explain, and is subordinate to the catastrophe of the centre. And the different views in the perspective of the temple, must have heightened these beauties.

Fig 2. is a section of the pediment, with its sculptures through the centre. It explains the manner of disposing the fallen hero at the feet of the Minerva, and the great depth ccupied by the statues within the general face of the entablature; every other crossing of the limbs in the composition is thereby rendered perfectly intelligible. The profile of the acroteria at the apex is also shewn, and its support rudely cut in the form of a lion.

Various suggestions have been offered as to the subject of the compositions intended to be represented by the sculptures on these pediments; the statues having a marked distinction of character, as of well known personages; nothing, however, very satisfactory has yet been suggested. The actions of the Æacidæ, the tutelary deities of the Æginetans, as far as they have been consigned to history, offer nothing explanatory;

though some resemblance may be traced to Horace's description of the combat between Homer and Ajax over the body of Patroclus.* Some light may perhaps be thrown upon this

---

* Ἂψ δ'ἐπὶ Πατρόκλῳ τέτατο κρατερὴ ὑσμίνη,
Ἀργαλέη, πολύδακρυς· ἔγειρε δὲ νεῖκος Ἀθήνη,
Οὐρανόθεν καταβᾶσα· προῆκε γὰρ εὐρύοπα Ζεὺς
Ὀρνύμεναι Δαναούς· δὴ γὰρ νόος ἔτραπετ' αὐτοῦ.

Colonel Leake has permitted me to insert the following note upon the subject. "I am much inclined to think that these noble lines indicate the important moment chosen by the sculptor of the pediments of the Panhellenium. The κνήμιδες observed on all the figures to the spectator's left hand, together with the absence of these Grecian articles of dress in the other division of the work, and the Phrygian bonnet upon one of the latter figures, seem strongly to mark that the subject is taken from the war of Troy. In the midst of the contest for the body of Patroclus, Jupiter sends Minerva to give new courage to the Greeks. On the western pediment she seems to have just descended from the skies; on the eastern, she has raised her arm against the Trojans, and the contest is decided. It may be objected perhaps, that this is not quite conformable to Homer, who represents Minerva as assuming the shape of Phœnix, and Jupiter as again changing his mind, and once more giving the superiority to the Trojans before the body was finally carried off by the Greeks. But every thing that we know of the productions of the ancients in the arts of design, shows that they were never servile imitators of the poets; and that a sculptor who had chosen a subject treated of by Homer would represent it in his own manner. Phidias may have been indebted to Homer for his first conception of his Olympian Jupiter, but every thing else about it was his own. It must be remembered also, that in pictures and compositions of statuary, the artist had to pursue a very different route from the poet. The latter had to narrate a succession of events, the sculptor to embody the action of a moment. If it should be thought that the death of Patroclus had little reference to Jupiter, the deity of the Æginetan temple, or to Æacus, its founder, it is to be observed, that it had fully as much connexion as the capture of Troy at the Heræum of Argos or the hunting of the Calydonian boar, and the battle of Telephus and Achilles, in the temple Minerva Alea, at Tegea, or the

subject, by a close examination of Greek vases, on many of which we find Minerva represented as present at an * heroic combat, and often precisely in the position and attitude here shown.

It is most probable, however, that the picture displayed some action famous in history, and that each statue presented a venerable and well known semblance of some noted individual of the family of the Æacidæ.

These heroes would naturally be placed in a temple erected in honour of their founder; for we are told by Pausanias,† that it was built by Æacus himself; not, however, that his expression should be unerstood literally, for it can only be supposed as applying to the original building, of which this, though itself very ancient, must have been a comparatively modern reconstruction. It was also believed that Æacus sprung from Jupiter; and this belief, with the attachment of the Æginetans to that family, together with the credit they had obtained amongst the Greeks, rendered their exaltation to this honour peculiarly appropriate.

It has even been suggested, that these might be the statues which, in consequence of a deputation sent for the purpose, were embarked on board the Grecian fleet, to assist in the battle of Salamis:‡ but though such a surmise be deserving

---

contests of the Centaurs and Lapithæ, and of Œnomaus and Pelops, in the temple of Jupiter at Olympia. In all these cases, the artist had to choose from among the mythological actions which were in any manner connected with the worship of the temple, that which in his judgment would produce the finest *picture*, and give the greatest scope to his genius. The defence of the body of Patroclus is represented by Homer as the most conspicuous among the exploits of Ajax, and in the estimation of the Æginetans Ajax, must have been the first of the Æacidæ, superior even to Achilles himself." W. M. L.

* See Millingen, Millin, Hancarville, and others.

† Corinthiaca, c. xxx.

‡ Herod. lib. viii. "The day appeared; and as the sun rose, "there was an earthquake, which was felt even at sea; upon this, "it was agreed to address prayers to the gods, and call the Æacidæ "to their assistance; this resolved, they prayed to all the gods

of little attention, from the situation of the statues, and the inconvenience of their size and weight, yet this circumstance, together with a parallel instance on an earlier occasion,* mentioned also by Herodotus, serves to shew the estimation in which the Æacidæ were held by all Greece as national warriors. It is to be supposed that they would be still more honoured in their native island; and we have thus the strongest presumption, that these statues were representations of the same heroes.

The rules of art, and its application to the symbolical or allegorical language of the Greeks, lay deeply concealed under the mysteries of their religion, their popular prejudices, or local traditions; and the contradictory theories of the learned in their disquisitions on the vases, and other remains of antiquity, are proofs of the little we can hope to recover from the data as yet in our possession.

As Minerva presides in both the groups which decorate the Panhellenium of Ægina, some have imagined the temple dedicated to that goddess; but, it should be considered, that as the emanation and symbol of the wisdom and power of Jupiter, Minerva was appropriately placed in the exterior of the building, within which, the more sacred and awful statue of Jupiter received the worship of the Æginetans.

In Plate II. is the eastern pediment, under which we found

" and off Salamis, where they were, they invoked Telamon and " Ajax; and they sent a vessel to Ægina to bring Æacus, with the " rest of the Æacidæ :———they were scarcely embarked, when the " vessel they had sent for the Æacidæ arrived;———but the Æginetans pretend, that the vessel they had sent for the Æacidæ " was the first in the attack."

* Herod. lib. v. " The Thebans sent immediately, according to " the oracle of the god, to ask assistance of the Eginetans, as their " nearest neighbours, and they promised to send them the Æacidæ. " The Thebans, full of confidence in the alliance of the Æacidæ, " took the field against the Athenians, but being worsted, they sent " a second deputation to the Eginetans to restore the Æacidæ, and " entreat them to furnish them their troops."

but five statues sufficiently preserved to assure us of their original destination and design; the destruction of the rest is much to be lamented; for, as the east was the principal front and entrance, and was viewed from a platform, extending one hundred feet in front of the temple, it was much the most magnificent, the statues being not only more numerous, but the style and perfection of the sculpture very superior; whereas, on the western side, there was a platform only of fifty feet, and the pediment did not present itself by any means so advantageously to the spectator.

As in the sculptures of the eastern pediment we trace the utmost effort of a master, those of the western appear rather the work of his scholars; the conception and execution of the former being much more grand, and of a higher character than the latter, the persons being represented more robust and muscular, with an imitation of a maturer nature; and though each statue be larger, yet it is remarkable that they occupy, on the whole, less room than the corresponding figures in the western pediment; for example, the arm of the combatant, Plate II., bearing a sword, requires less room than the corresponding figure in the west; in like manner the archer, though a much larger figure, yet being without the crest, has less elevation; and the fallen hero behind him is more closely adapted to the angle of the pediment: for these reasons, I am induced to believe, that there were more figures in the eastern than in the western pediment, though the compositions have, in other respects, a strong resemblance. The fragments of twenty-five statues were found on the whole, besides the four female statues which adorned the acroteria; of these, eleven occupied the western; and I have every reason to believe that there were fourteen in that of the east.

From every circumstance which we know relative to the history of Egina, it is probable, that the temple which forms the subject of the present memoir, was built before the year 520, B. C.; after which period, the rapid rise of the Athenian power wholly occupied the exertions, and endangered the political existence of Egina, until it was ultimately subjected to its

more powerful neighbour. It was during the preceding century that Egina was in the height of her prosperity and power, and when she was one of the most flourishing commercial republics of Greece. Some period of this century, therefore, may fairly be presumed to be the date of the construction of the Panhellenium; and the style of sculpture accords perfectly with this æra; it is such a school, in short, as we should expect to find in an age not long preceding the perfection of the time of Pericles; but though considerably prior to the meridian of art, it is also far removed from its dawn; the singular boldness of position, the variety of attitude, so favourable to the display of the human figure, the ingenuity and artifice in the compositions of the groups, shew the matured studies of a long established school, in which, not the first efforts, but the tried and acknowledged excellencies are united and put in practice.

The history of imitative arts can only be explained by their productions; the exact resemblance of prototypes form the first æra, precise rules are then necessary, to apply and retain the principles acquired; and the early masters of every country have been remarkable for fixing a standard, as an unerring guide to themselves and their disciples; as if apprehensive of losing what the mind has been so long in discovering.

When correctness is attained, and the discipline of a careful observation has been long practised, further scope may be allowed to genius: and for the acquirement of greater beauties, the rigidity of rules may be occasionally relaxed; licentiousness is too apt to follow; and the love of novelty is the prelude to the degradation of the art.

The course of the revival of the arts, from the twelfth to the sixteenth century, is exactly parallel with that which history affords us of their origin, from the sixth to the third, B. C.; and the statues of Ægina are admirably illustrative of the second period. A canon of proportion, and a system of anatomical expression, are observable throughout these marbles; and it is evident, that a long practised rule has been applied to each part of them; though still severe, already the art appears to have arrived at the eve of new conceptions; a bolder and

more perfect style seems to be promised; what the works of Ghirlandaio were to Raphael, these were to Phidias and his cotemporaries; and the hand of genius, such as his, was only wanting to bring sculpture to perfection.

Amongst the remnants of antiquity, there are few examples of positions bolder and more difficult of execution; the fighting Gladiator and the Laocöon, are, perhaps, the only other statues of antiquity that can be compared to them for energy of action. The monotonous simplicity of former stages of the art is thrown aside; and the spectator is filled with surprise and admiration at the effect of a triumph over difficulties, superadded to the beauties of form and execution which had been already attained. The attitudes are all momentary; they are not those of an Academy figure, in executing which the model gives time for a careful study of its forms; but with a perfect possession of the science, and with an intimate knowledge, rather than by an actual copy and imitation of nature, they are, as it were, the conception of a painter embodied in marble.

The position of Figure No. 5, in Plate I., is extraordinary; it is at the moment of receiving the fatal blow; he is still falling to the ground, and the right arm, stretched out to save him, is yielding under his weight; the head sinks, and his left hand lets fall the shield, as if in the languor of approaching death; in this, as well as in the corresponding figure in the eastern pediment, the whole of the weight was upon the hand.

No. 4 and 8, are rushing to the attack; and the actions of these figures, balanced, without any other support, upon their feet alone, are bold and surprising. The actions of the archers are instantaneous; No. 9, is at the moment of discharging his arrow; while No. 5, seems watching its effect. No. 2 and 10, are positions of not less merit in these respects; and in No. 1 and 11, a desire is perceived to give even to these the interest of action. The singular position of the right leg is calculated to give movement to the figure, as viewed from below; indeed all of them have this remarkable advantage;

and the limbs of the whole, thus extended and detached, must have had a surprising and pleasing effect.*

However apparent in these statues is the desire of emancipating the art from its primitive dryness,† the physiognomies of all the figures have, nevertheless, an ideal character evidently stampt upon them. No variety of expression is even attempted; as if an inanimate resemblance to some antique statues had been adopted from motives of personal veneration, similar to that which, in the revival of the arts in Italy, induced all the masters, till the time of Raphael, to imitate the physiognomy of the Madonna, as painted by St. Luke, and it is to this cause that we may ascribe the circumstance of the heads of the Ægina statues having a character far more archaic than the rest of the figure. A smile is seen on all the mouths; the cheeks are rather hollowed, the lips are thick, the nose is short, but angular and prominent; the eyes are protruded, the forehead is flat and retiring, and the chin is remarkably long, and rather pointed; the hair and drapery are arranged with the greatest precision.

In the temple of Ægina, we have a very remarkable, and very ancient example of the practice which prevailed among the Greeks,‡ of painting their sculpture; for the style and execution of the colours found on the statues and ornaments of the temple, prove that they cannot be of any other date than the original construction.

The particular notes on the statues, will shew the various portions of them which were painted; in order to relieve the statues, the tympanum of the pediment was of a clear light blue: large portions of the colour was still seen on the fragments as we raised them from the ground.

The moulding, both under and over the cornice, was painted;

* For further particulars concerning each statue, see the notes to the plate.

† ἡ συστολὴ καὶ ἰσχνότη of Demetrius Phalareus de elocut. xiv.

‡ Pliny and Pausanias expressly inform us, that this was a practice of the greatest sculptors of antiquity. The temples of Athens furnish many examples of it.

the leaf was red and white, and the superior moulding of the cornice was painted in encaustic; the colours being on marble, and more exposed, had long disappeared, but the relief in which the part so covered, was found, indicated very perfectly its outline.

In considering a custom which appears so extraordinary to us, it must be recollected, that although the Greek buildings were grand in conception and idea, their scale was small; hence they required a greater nicety and delicacy in the execution: the colours served as the means of distinguishing the several parts, and heightening the effect by a delicate variety of tones, so as to relieve what might otherwise be inanimate or monotonous. To paint white marble, or other stone exposed to the open air, appears very singular to us, but there are many considerations not obvious to our northern ideas and prejudices, which must be taken into the account. In Greece, the mildness of the climate, and purity of the atmosphere rendered works of finished execution much more secure from degradation; and admitted refinements of sculpture and painting, that would be thrown away and lost in a northern climate, the inhabitants of which finding little enjoyment in the open air, are obliged to lavish upon their interior apartments, those luxuries of sculpture and ornament which the ancients, passing a great part of their time in their fine atmosphere, or under the shade of porticos, bestowed upon the exterior of their building.

Art. XVI. *On White Arsenic.* *By Dr.* Paris.

Dear Sir, *Dover-street, Dec.* 18, 1818.

After the various controversies upon the subject of arsenical tests, it is not a little singular, that the discordance which exists in the different chemical works of authority, upon one of the most important characters of arsenious acid, should have escaped animadversion. *Does the arsenious acid, when*

volatilized, yield any alliaceous, or perceptible odour? The fact is, that unless the arsenical vapour be deoxidized by the presence of some body which has a powerful affinity for oxygen, it is perfectly inodorous, the alliaceous or garlic-like smell being wholly confined to *metallic* arsenic in a state of vapour; such a deoxidation takes place when the arsenious acid is thrown upon ignited charcoal, or when heated in contact with those metallic bodies which readily unite with oxygen, as *antimony, tin,* &c. It is stated by Orfila, and other chemists, that if it be projected upon heated copper, the alliaceous odour is evolved; this certainly takes place if the copper be in a state of ignition; for at that temperature its affinity for oxygen enables it to reduce the arsenious acid; but if a few grains of this substance be heated on a plate of copper, by means of a spirit lamp, or a blow-pipe, no odour is perceptible, for the whole of the acid is dissipated before the copper acquires a sufficiently exalted temperature. If the arsenious acid be heated on a plate of zinc, the smell is not evolved until the zinc is in a state of fusion; if, instead of these metals, we employ in our experiments gold, silver, or platina, no alliaceous smell whatever is produced. The practical application of these facts, and their extreme importance in medical jurisprudence, are so obvious, that no apology is necessary for troubling you with a detail of them. Mr. Faraday has obliged me by repeating them in the laboratory of the Royal Institution, and with results similar to those which I have stated.

I have the honour to be,

your obedient Servant,

JOHN AYRTON PARIS.

To W. T. Brande. Esq, &c. &c.

Art XVII. *Proceedings of the Royal Society of London.*

In consequence of the melancholy event of the death of Her Majesty, the ordinary business of the Society was suspended during two meetings.

The sittings were resumed for the season, on Thursday, the 5th of November, when Sir Everard Home read the *Croonian Lecture.*

In a former Number of this Journal, we have given some account of Sir Everard's investigations into the phenomena presented by the blood during its coagulation. On the present occasion, he has offered some further remarks upon that subject, and has more particularly directed his attention to the conversion of pus into granulations of new flesh. The changes which this fluid undergoes, correspond so closely with those shewn to take place in the blood, that the two fluids appear to possess nearly the same properties, the red colour of the blood's globules being the principal difference. Sir Everard thinks, that an important step in the formation of a vascular part from pus, consists in the extrication of globules of carbonic acid, which coalesce so as to form canals, through which the red blood afterwards circulates, and thus connects the new part with the general circulating system. On this, as on the former occasion, Sir Everard has availed himself of Mr. Bauer's pencil, and a number of beautiful drawings were shewn, in illustration of the doctrines in the paper.

Thursday, Nov. 12. Dr. Brewster communicated a paper on the laws which regulate the absorption of polarized light by doubly refracting crystals. In a mere report, it is impossible to do justice to the important facts and experiments contained in this paper; and as we shortly hope to furnish our readers with a connected view of Dr. Brewster's discoveries in this interesting department of natural philosophy, we are the less anxious to enter into particulars at present.

The Meetings on the 19th and 26th, were merely for the purpose of transacting such business as was peremptorily required by the statutes of the Society; and on the 30th, being

St. Andrew's day, the usual annual election of the President, Council, and other officers, took place. Upon this occasion also the Copley Medal was presented to Mr. Robert Seppings, for his various improvements in ship-building, communicated to the Royal Society, and published in their Transactions. The President, in a very interesting discourse, took a luminous view of these various improvements, and of the means by which they had been accomplished; he adverted to the attempts which had been made abroad to detract from their originality, and drew a just line of distinction between the merit of suggesting the possibility of an improvement, and that of carrying it into practice; the latter merit belonged, he said, to Mr. Seppings alone. The President concluded by trusting, that the honour now conferred, would induce Mr. Seppings to prosecute his investigations with increased diligence, which had already added so much to his own reputation, and which were so intimately connected with the safety and comfort of sailors, and in which the liberties and prosperity of his country might be involved.

Thursday, Dec. 10. A paper was read, entitled, "Observations on the Decomposition of Starch, by the action of air and water, at common temperatures, by M. Theodore de Saussure."

It was shewn some time ago, by M. Kirchoff, that by boiling starch with very dilute sulphuric acid, a portion of it was converted into sugar. M. de Saussure has now shewn, that during the changes which a solution of starch undergoes by exposure to air, while it becomes mouldy, a portion of sugar is also formed. Another part of the starch is, it appears, converted into gum.

Thursday, Dec. 17. Mr. Babbage gave a paper on the solution of some problems relating to games of chance, which being entirely mathematical, was not read.

Art. XVIII. *Mining Intelligence.*

An increased activity in the mines of this kingdom has been the consequence of advanced prices in most of the metals; copper and lead particularly have been much in demand, and are now of greater value than during several former years. Tin has been heavy of sale; the produce, formerly limited almost entirely to Cornwall, probably was not beyond the common demand; but of late, considerable quantities have been raised in the island of Banca; and some of the Cornish mines being at the same time unusually productive, the markets seem to have been overstocked. The tin mines, therefore, do not partake of the advantage arising from high prices; the demand for this metal, however, is improving, and it may be hoped, will yet enable many to continue working, which must have stopped if the depression had been permanent.

Copper is only raised in quantity in Cornwall, Devonshire, Anglesea, and Staffordshire: of all these the produce of Cornwall is by far the most important, amounting in the year 1817 to more than 6500 tons of fine copper.

The mines in the parish of Gwennap are the richest, and most effectually worked; their produce is now very large, and their profits, generally speaking, considerable. *Treskerby* and *Wheal Squire*, though not mines of the greatest extent, are mentioned as affording very large returns to their proprietors. Some new lodes are discovered by the present adventurers in *Tresewean*, by pursuing the levels which were not long ago abandoned by others, and which promise to render it a very valuable concern.

A company has just been formed to work the consolidated mines, including *East and West Wheal Virgin*, *Wheal Lovelace*, with the addition of *Wheal Fortune*; all which were stopped some few years since. The capital to be employed is 60,000*l.*, which has been rapidly subscribed, and preparations for this great undertaking are in hand. The lodes on which these

mines have been worked are of known value, and are in the centre of the most productive district; and with the spirit with which they will now be prosecuted, and the encreased skill in the art of mining and of constructing engines, no doubt is entertained of their success. The more western copper district of Cornwall, near Cumborne, is also now considerably productive; and *Dolcoath*, one of the deepest and most extensive mines in the kingdom, is richer of late than for some time past.

Turning eastward, the country near St. Austel may be considered as a new field for the exertion of the copper miner; *Crennis*, which was for a time so abundantly rich, is not at present so valuable; but other mines near it have been discovered, and a great deal of ore will probably continue to be raised.

In Devonshire, the mines being on the borders of the county, and found in similar rocks, may almost be considered to belong to Cornwall, and are worked upon the same system. *Wheal Friendship*, in Mary Tavy, is now by far the richest, and is returning a large profit, chiefly from discoveries in the deeper levels, about 140 fathoms from the surface.

In Anglesea, the famous copper mine at *Paris Mountain* is said to have regained some of its former prosperity, and that discoveries have been made by spirited trials in some parts of the old works.

The Staffordshire copper district is limited to a small space, but which includes perhaps the most ancient, and, probably, what has been the richest mine for its extent in the kingdom, that of *Ecton*, long worked by the Dukes of Devonshire. The ore is rich, and found in limestone, not in any regular vein, but in a deposit, which has not been well described, and which, in the language of Derbyshire, passes under the general denomination of a *pipe*. It has been worked in one part to the great depth of 220 fathoms, but the bottoms have not been seen for several years, and are now buried in water.

Another, and somewhat similar mine, is working in the same hill, and is likely to be productive. The Cornish system of management has lately been introduced, and various

works are now pursuing with great activity, to the benefit of the neighbourhood. It promises to be an interesting object to the traveller, among the other curiosities of the surrounding country; and access and information are liberally afforded to those who require it.

Another copper mine, called *Mixon*, is situate within a few miles, on the estate of Mr. Sneyde, which has produced a considerable quantity of ore.

The lead districts of England are so numerous, that we can notice them but in part, though we should gladly receive information as to all.

In North Wales, the rich mine in the *Holken* mountain, on Lord Grosvenor's estate, has been embarrassed by the increase of water, and the produce has in consequence been much diminished. A deep level from the lower part of the mountain is said to be in contemplation.

The great mines at *Minera*, near Wrexham, would be vastly productive, if the same difficulty did not exist; and the quantity of water sometimes raised by six large steam engines, which are occasionally all at work, is uncommonly great.

The long Holywell level, which has been the means of discovering and raising great quantities of lead from various veins which it intersects, has been lately surveyed accurately, and plans for further trial are under consideration.

The Derbyshire lead mines are not, generally, in a flourishing state; and an opinion seems prevalent, that the richness of the veins diminishes as they are followed in depth. One mine, near Bakewell, has lately been very productive: but no concern of magnitude is to be found in this county, where a peculiar code of mineral laws tends to prevent a well arranged system of conducting mines on a large and liberal plan.

In Yorkshire lead ore is found in veins in the gritstone, which have, in many cases, been worked down to the limestone on which it rests, with little interruption from water. In the latter rock, however, it does not escape; and the difficulty of following the veins, which appear to continue with equal or greater richness, is much increased.

On Grassington Moor a level is driving by the Duke of

Devonshire, which, when it reaches its destination, will drain a vast number of lead veins, which have been formerly worked as deep as the water would permit. This great undertaking has been more than twenty years in hand with unremitted exertion, cutting through very hard limestone, and proceeding slowly, and with difficulty, to its object. The length already executed is about a mile and a half, and some veins are likely soon to be drained by it. To make it completely effective, it must, however, proceed much further; and measures have lately been concerted to expedite it as much as possible. A deep shaft on its course, to be provided with a very powerful steam engine, which may at the same time drain some of the old mines, and afford means for driving to meet the main level, is said to be in contemplation.

A curious mine, which is worked in a horizontal bed of metalliferous limestone, on *Buckden Gavel*, not far from Kittlewell, is now very productive; its ores are remarkably rich, and contain a considerable mixture of compact carbonate of lead, with large masses or nodules of galena; the whole imbedded in a loose ochrous earth, occupying various positions in the bed of limestone, but not extending beyond it.

Art. XIX. *Miscellaneous Intelligence.*

I. Mechanical Science.

§ 1. Astronomy, Mechanics, &c.

1. *New Comets.*

M. Pons, of Marseilles, has discovered a comet in the constellation Pegasus, and two days afterwards a second, in the constellation Hydra. According to the observations of M. Blanpain, this new comet was, on the 30th of November, at 17 h. 37 m, of mean time, reckoned from mid-day at Marseilles, by 179°.38′ of right ascension, and 29°.17′ south declina-

tion. On the 1st of December, at 17 h. 57 m. of mean time the right ascension was 180°.39′, and the declination 28°.47′.

This comet is visible through a night telescope. It has a pale nebulosity, is round, and from five to six minutes in diameter. The nucleus is very confused. It is expected shortly to become more brilliant, and visible, even to the unassisted eye.

2. *New Carriage.*

A novel sort of carriage has been invented by Mr. Charles Drais, which is said to offer some advantages to those who wish to travel with but little incumbrance. It requires no aid of horses or other animals, but is impelled forward by the force of the person seated on it. It is founded on the principle of skaiting, being, in its simplest state, a mere seat fixed on wheels, which is to be moved by the feet acting on the ground. The first machine has been much improved, by the addition of other useful parts to it, as a balancing board, a guiding pole, and machinery, which facilitates the application of the rider's powers to its due purpose. As long ago as July last, and before the late improvements, the inventor went from Manheim to the Swiss relay house, and back again, a distance of four hours journey by the post, in one hour; and he has lately, with the improved machine, ascended the steep hill from Gernsback to Baden, which generally requires two hours, in about an hour.

3. *New Moving Power.*

It is proposed by M. Pattu, a French engineer, to produce a new moving power by an application of the expansion which takes place in water during its elevation from low to high temperatures, without its conversion into steam. The way in which this is to be done, may be readily conceived by recurring to the motion in a thermometer; but the objection is, its extreme slowness. M. Pattu, however, thinks, that the immense power of expansion in heating water will compensate this circumstance, and admit of a conversion by the usual methods, of this slow but irresistible power, into a more rapid and generally useful one; and to shorten the time of the first motion,

the heated water is not to be cooled in the engine, but removed and replaced by cold water.

2. Architecture, Agriculture, Manufactures, &c.

1. *Souterazi of Constantinople.*

The following description of one of the modes by which the conveyance of water is practised at Constantinople, is taken from Andréossy's Travels to the Black Sea, &c. lately published at Paris. "The souterazi are massive pieces of masonry, having, generally, the form of a truncated pyramid, or of an Egyptian obelisk. To form a souterazi conduit, sources of water are first selected, the level of which is superior, by several feet, to that of the distributing reservoir which is to be constructed. The water of these sources is carried in subterraneous canals, slightly inclined, until obstructed by a deep valley, glen, or other separation of the surface; there is then formed, on the side where the canal terminates, and also on the opposite side, *souterazi*, to which are adapted, at the opposite sides, vertical tubes of lead of a determinate diameter. These tubes are not connected above, except by a basin; so that the water rises into the basin through the first tube to the height from which it had descended, and it descends by the second to the foot of the *souterazi*; here there is another subterraneous canal, which conducts it to a second and third *souterazi*, where it rises and falls, until it reaches its ultimate station; there a reservoir receives it, from which it is distributed by orifices, the capacity of which, and power of delivery are known."

"It will be easily seen, that this system of conduit pipes is no other than a number of inverted syphons, open at the superior part, and communicated together. The expense of a *souterazi* conduit is estimated at one-fifth of that of an aqueduct on arches. The usual distance between two souterazi is about ninety toises."

2. *Method of destroying Insects.*

A farmer of Pensylvania states, that "the water in which potatoes are boiled, sprinkled over grain or plants, completely destroys all insects, in every stage of existence, from the egg

to the fly." This is not very evident, and the assertion in full is probably premature; it is, however, worth the trial.

3. *Improvement in Seed Grain.*

It has been observed, that heated grain, when used as seed, is more generally productive than common grain; and in some rough experiments, where there have been no failures in the vegetation of grains that have been sown after having heated, as many as 12 or 13 in a score have failed out of good common seed. These observations have induced an inquiry into the probable economy of using heated grain for seed in place of the common seed; and, it is hoped, the general result will prove advantageous.

4. *New Life Boat.*

A new life boat has been invented by Lieutenant Allen F. Gardiner, R. N., and from the trials made with it, is expected to present advantages over those in present use. It supports the weight of 18 men, when filled with water; and when completely overset, though with mast and sail standing, rights again without aid.

5. *Letter from Captain Kater to the Editor, relating to the Instruments provided for the Arctic Expedition.*

My Dear Sir, *London, Nov.* 1, 1818.

In consequence of my late absence from town, I have only just seen the Tenth Number of the Journal of the Royal Institution, in which I find a copy of the instructions for the use of the instruments provided for the Northern Expedition. In those instructions I have fallen into an error, which I did not perceive until they were printed, and I must request you will have the goodness to point it out in your next Number.

Under the "method of using the Variation Transit," I have directed the logarithm of the time of the sun's semidiameter passing the meridian given in the Nautical Almanack, to be added to the difference between the cosine of the latitude of the place of observation and that of Greenwich; but this is incorrect, for the time of the sun's semidiameter, passing the meridian, is

not affected by a difference of latitude, but solely by a change of declination. The time therefore, as found in the Nautical Almanack, should be applied as directed in the "instructions" without any alteration.

I am, my dear Sir,

Your faithful obedient servant,

W. T. Brande, Esq. HENRY KATER.

6. *Terazi or Grecian Level.*

The *Terazi* is nothing else than the mason's level inverted; that is, having the upper part beneath and the lower above. To this, the upper part in the terazi, are fixed two hooks, which serve also for the attachment of a cord by which it may be suspended, and which is carefully secured. The use of this instrument consists in making the middle of the cord correspond to the middle of the base, to which is attached a lead and line, and one of the ends of the cord being fixed, the other end is to be raised or lowered until the leaded line and the middle of the cord are in the same vertical plane, which is perpendicular to that of the cord. In this situation the points of suspension are level with each other, and nothing more is to be done than measure the difference in height which it indicates.

In place of writing these differences, the Greek fountaineers mark them by a small string, which they roll round the four fingers of the left-hand, holding tightly between the fore-finger and thumb, the place of the string which marks the last difference of level noticed: when in this way all the differences have been gathered upon the string, it is unrolled and measured and the total difference in level ascertained.—*Andréossy.*

7. *Tar Lamp.*

The American papers describe a lamp in which tar is burnt instead of oil. The quantity of this substance, which is produced by the gas manufactories in England, have rendered it of scarcely any value, and an application of it to some of the common purposes of illumination would be important. In consequence of the fluidity of this tar it would be more readily applied than common tar, and the apparatus or rather lamp of the Americans would probably do with very little modification.

It consists of a fountain reservoir to supply and preserve a constant level, and a lamp, which receives the fountain pipe at one end, and at the other has a burner for the tar: this is merely a small cup placed in the axis of the lamp, and supplied with tar from the fountain. A draught tube is fixed in the lanthorn or external part of the lamp, and air is admitted by a hole at the bottom. The current of air in passing through the lamp, envelopes the burner and urges the flame, and the draught tube conveys off the smoke.

II. Chemical Science.

§ 1. Chemistry.

1. *Prize Questions.*

The Royal Academy of Sciences, Belle Letters, and Arts, of Rouen, propose the following question as a prize subject for 1819: "What are the methods dependant or independant of Wedgewood's Pyrometer, the most proper to measure with precision the high temperatures required in certain arts, as those of the glass, porcelain, or iron furnace." The prize is a gold medal of 300 francs value. The papers to be written in French or Latin, and sent in before the 1st of July 1819.

The following subjects are proposed by the Academy of Sciences of St. Petersburgh:

1. To repeat the experiments made on potash and soda and on the metallic bases which they contain, and to examine with the greatest accuracy the results which may be deduced.

2. To subject ammonia to a particular and careful examination, so as to establish decidedly the relative merit of the opinions entertained respecting its nature and composition; and the possibility of insulating the pretended metal it is said to contain.

3. To examine more accurately than has yet been done the metallic substances obtained from the earths: to ascertain the possibility of obtaining them in their pure and isolated state: to detail their properties in that state, and in combination with

other substances; and to indicate the various and determinate relations in which they may be placed.

The premium is a hundred ducats of Olanda and a hundred copies of the Memoir which shall be received. The papers should be presented to the Secretary of the Academy before the 1st of January 1820.

The Society of Sciences of Haarlem have announced the following subject for competition, the prize being a gold medal or 150 florins. "In the new mode of distillation which some years since was originally practised at Montpellier, and has since been adopted and improved in the South of France, according to which the substances from which spirituous liquors are extracted are not immediately exposed to the action of fire, but heated by steam, a process which is not only more economical than the ordinary method, but which has this additional advantage, that the spirituous liquors produced by it are purer and of a more agreeable taste." The Society desires to know, "What is the best apparatus for extracting, according to this method, with the greatest profit, the purest spirituous liquors from grain, as wine is drawn from the vines of France?"

2. *Sugar in Potatoes.*

M. Peschier of Geneva, has ascertained by some experiments, (an account of which is inserted in the Bibliotheque Universelle), the presence of sugar in the potatoe, accompanied also by a portion of gum. Some rasped potatoes were left for some hours in water, and then pressed and dried. All soluble matter had not, however, been removed from them, for 25 ounces of this starch thus obtained, being digested in eight pints of cold water, for 24 hours, gave a solution, which by evaporation, yielded a brown, adhesive, and sweet substance. This treated with alcohol, was separated into two parts; about 100 grains of sugar were dissolved, and the residue, when acted upon by water, gave 350 grains of a gum, and a very small quantity of insoluble matter.

It is not supposed probable that this should be all the sugar

potatoes contained; a part had, no doubt, been removed by the first washing of the fecula, and from the apparent affinity between the starch and the sugar, a part was probably retained by it. M. Peschier, impressed by the result of his experiments, is induced to believe that the value of the potato, as an object of culture, will be increased by a knowledge of the above fact; and also to think that it is decisive, but opposing evidence to the opinion, that alcohol could be formed by the fermentation of substances not containing sugar.

3. *Purification of Borax.*

M. M. Robiquet and Marchand, recommend the following process for the purification of borax, as being the most economical and simple. If in the state of tincal, the crystals are to be put into a tub, and covered to the depth of 4 inches with water; it is to be left thus, that the impurities may become suspended in the water, being stirred from time to time. At the end of five or six hours, a four hundredth part of slacked lime is to be added, and mixed with the crystals, the whole being then left till the next day. The crystals are then to be removed by a sieve, which is to be kept in agitation, that the impurities may be washed off, and are then left to drain. When all the borax is removed, the water is to be thrown into another vessel, where it immediately deposits its impurities, and at the end of a quarter of an hour it may be again used to re-wash the crystals, and this is to be repeated until it comes off from them clear; they are then to be washed with a small quantity of fresh water.

The borax cleansed thus far, is to be dissolved in two and a half parts of water, and for every quintal about 2lb. 3 oz. of muriate of lime is to be added; it is then to be passed through a filtering bag, and is obtained colourless; it is to be evaporated, and left to crystallize in vessels of white wood or of lead, to which it will be most convenient, to give a conical form, because during crystallization a deposit sometimes forms, which renders the lower part of the mass obtained impure and imperfect, and every care should be taken to render the crystallization slow, otherwise, in place of well formed crystals, only irregular crusts and compact masses will be obtained.

Vessels of white wood are recommended, because other woods tinge the borax. In this process the loss of weight is not more than 10 per cent. and consists of extraneous matters. The cold water removes nothing but the soapy substance formed by the lime with a particular impurity accompanying the borax, sulphate and muriate of soda, and a very small quantity of borax.

When the borax used is that which has been partly refined, the washings may be dispensed with. It is to be immediately dissolved in water, with the addition of two or three per cent. of muriate of lime, varying with the quality of the borax, and the process conducted as with the tincal.

4. *On the Calcination of Potash with an Animal Substance.*

According to some experiments related in my Researches on Prussic acid, I believed that a cyanuret of potash was obtained by calcining that alkali with an animal substance; but I soon assured myself that in reality, a cyanuret of potassium was formed.

If cyanogen be combined with potassium, and the product be dissolved in water, it is easy to ascertain that it has all the characters of the hydrocyanate of potash made by the union of its constituents: it will be decomposed by the acids, but they will liberate nothing but hydrocyanic acid, and will form no ammonia.

If, on the contrary, cyanogen be absorbed by a solution of potash, and an acid, be afterwards added, it will produce carbonic acid gas, hydrocyanic acid, and ammonia, of each a volume equal to that of the cyanogen employed. The two first bodies are observed immediately after the addition of the acid to the cyanuret of potash; the ammonia remains in combination with the acid, and to render it sensible, lime in excess must be added.

Now, the substance produced by calcining an animal body with potash being dissolved when cold in water, afterwards treated by muriatic acid, and then by excess of lime, does not produce ammonia, and appears to act precisely as the cyanuret of potassium. It is very important not to throw it into water whilst red, or even hot, for it is then decomposed, and produces much ammonia. It must not even be left to cool with

free access of air, for I have seen it several times ignite like pyrophorus. Lastly, water must be avoided as much as possible during the calcination of potash with animal substances. G. L. *Annales de Chimie*, T. viii. p. 440.

5. *Separation of Manganese from Iron. By M. Faraday, Chemical Assistant at the Royal Institution.*

Some observations were made in the last Number of this Journal at page 153, on the best means of separating manganese and iron from each other in analysis; one or two other methods may be here given in addition to the one of Mr. Hatchett's there recommended; depending partly on the tendency of manganese to form triple salts with ammonia, and partly on its power of decomposing ammonaical salts.

The pure alkalies do not affect the triple salts of ammonia and manganese.

White oxide of manganese put into a solution of muriate, sulphate, or nitrate of ammonia, instantly decomposes a portion of it, the oxide is dissolved, and a triple salt formed, and the solution becomes alkaline from ammonia liberated.

Per-oxide of manganese does not decompose a solution of muriate or sulphate of ammonia by boiling, but if a little sugar is added, a decomposition takes place, carbonic acid is liberated, and a triple salt formed as before.

If, however, per-oxide of manganese be heated with these two salts, it decomposes them, ammonia is liberated, a part of which is decomposed by the oxygen of the manganese, and a chloride or a sulphate of manganese is produced.

Iron acts very differently when placed in similar circumstances, and on the differences are founded the following methods of separation:

To a mixed solution of iron and manganese, add solution of muriate, sulphate, or nitrate of ammonia, and then pour in pure potash: the iron will be precipitated immediately, but the manganese will remain in solution as a triple salt, unaffected by the free alkalies.

In this method of analysis, the muriate or sulphate of

ammonia is better than the nitrate, because the latter *may*, in impure solutions of the metals, produce a portion of per-oxide of manganese, which would be precipitated; the quantity of ammonical salt added should, for the sake of security, be not less than double the quantity of salt of manganese supposed to be present; and the iron should be in the state of per-oxide, otherwise, as the protoxide is soluble in ammonia, a part would remain in solution in the ammonia, set free by the potash. If the iron is not in the state of per-oxide, it may be easily thrown down, by exposing the mixed solutions of salts and alkalies to the air, or by driving off the free ammonia by moderate heat: the triple salt of manganese will not be affected.

Another easy mode of separation is to throw down the oxides together from the solution, the iron being per-oxidated, to wash them by decantation, and to digest them in muriate of ammonia, with a little sugar: the manganese, (both prot and peroxide,) will be dissolved, and the iron will remain. M. F.

6. *Manganese.*

I have succeeded in getting metallic manganese in large globules, from the triple tartrate of manganese, (p. 158) by heating it in a wind furnace, *per se*. In consequence of a portion of charcoal getting from the fire into the crucible, it was not entirely free from iron

A pure preparation of manganese for the production of its other salts may be obtained at once, by heating excess of common black oxide of manganese with muriate of ammonia in a crucible. The chlorine takes the manganese in preference to any other substance present; and on dissolving the mass in water, and filtering, a pure solution of muriate of manganese is obtained. No iron is taken up by the chlorine in this process, as long as manganese is present; and I have not even been able to find copper, nickel, or any other metal in solution. By evaporating the solution to dryness, and fusing it out of contact of air, the crystallized chloride is obtained.

M. F.

7. *Carburetted Hydrogen.*

An error has entered amongst the generally received opi-

nion respecting light hydro-carbonate, which in consequence of its influence on some modes of chemical analysis, it is worth while correcting. Light hydro-carbonate has been distinguished from olefiant gas by the want of action which chlorine was supposed to have on it in the absence of light; and sometimes from pure hydrogen, by the want of a similar action when exposed to the sun's rays. I find, however, that in both these circumstances, chlorine and light hydro-carbonate, or light carburetted hydrogen, suffer mutual action, and that effects are produced, which, though modified by the quantities of the gases and other circumstances, are still such as might be expected from the effect of olefiant gas and hydrogen gas with chlorine.

If the gas obtained from the acetate of potash by distillation, from coal by the same means, or from alcohol at a red heat in a gun barrel, be mixed with about twice its bulk of chlorine, and exposed in a dry close vessel to the sun's rays when bright, it will in a few moments explode, depositing charcoal; but if not too powerful, an immediate action of a different kind will be seen to take place; the vessel will become filled with a cloud, which in a short time collects in drops, consisting of the fluid formed directly by adding olefiant gas to chlorine; and muriatic gas also is produced. If the quantity of chlorine be not sufficient to combine with all the hydrogen liberated by the formation of the ethereal fluid, still the decomposition of the light carburetted hydrogen is effected, and pure hydrogen remains in the vessel as one of the products, the ethereal fluid being the principal one.

These effects seem due to the tendency there is to form the triple compound of chlorine, charcoal, and hydrogen, described by the Dutch chemists; and it is evident, from the circumstances of their combination, that the affinity which unites these three bodies is very powerful, and very easily exerted. The rays of the sun in London at three o'clock, in the middle of November, were sufficient to produce the effect immediately, and it takes place, even without light, in three or four days.

From the decomposition of the light carburetted hydrogen gas and re-arrangement of its elements with the chlorine to form the ethereal compound, even when no combination took place with the liberated hydrogen, there can be little doubt but that it is a direct combination of the elements, and not a mere case of union between chlorine and olefiant gas. M. F.

8. *Nitrous Oxide.*

Instances have occurred where the respiration of this gas has been said to produce, in place of pleasant sensations, very injurious and alarming effects on the health of the body and state of the spirits; but it is probable that many of these have been occasioned by impurities in the gas. There are two or three products very frequently obtained in small quantities, by the distillation of common nitrate of ammonia, which, if not removed from the nitrous oxide, must have injurious effects: these are chlorine, the vapour of azotane or chloride of nitrogen, and perhaps may be mentioned also nitrogen.

When muriate of ammonia is present with the nitrate of ammonia, these substances are always disengaged: if the quantity of muriate is small, they may be removed by standing over water, but when occurring in large proportions, they remain for some time in the gas. When a mixture of nitrate and muriate of ammonia are heated together, there is an action between the elements much more violent than if the nitrate were pure, a great proportion of the muriate is decomposed, and but little distils over unaltered. It would seem that the nitrous oxide in the nascent state acted upon both the ammonia and the muriatic acid, for the products of a distillation of this kind are nitrogen, chlorine, muriatic acid, and a portion of the chloride of azote in vapour, and scarcely any nitrous oxide is obtained.

It is evident, that a gas containing the above substances in mixture must be very deleterious when respired; and I have rarely found the nitrate of ammonia of commerce that did not produce them. It is however easy for the person who is aware of their possible formation to guard against their ill effects, by testing the first portions of gas that come over. When a nitrate containing muriate is distilled, the first effect is a mutual

decomposition of the salts, and a resolution of them into the substances mentioned, and this go on until all the muriate is destroyed (supposing the nitrate in excess); the nitrate is then left pure and gives excellent gas, though before scarcely any nitrous oxide could be obtained from it. The odour of the gas is sufficient, even without any reference to the usual tests of the purity of nitrous oxide, to tell the presence of chlorine and chloride of nitrogen in the first portion; and when the gas obtained by a moderate distillation, is free from the peculiar odour of these bodies, it may always be breathed with safety, except by the few who experience effects apparently anomalous to those which belong to the gas. M. F.

9. *Alkali in Vegetables.*

M. Peschier, of Geneva, has furnished a method to chemists, by which the presence of alkali in vegetable may be demonstrated without incineration. It consists simply in forming with the acid always found in excess in vegetables, an insoluble salt by magnesia; the potash then becomes liberated and may be shewn in solution. Any vegetable infusion being boiled for a few minutes, with a sufficiency of magnesia to saturate all the acids it contains, and then filtered, will give a solution which renders vegetable blue colours, green, and yellow colours, red, which effervesces with an acid, and which contains, in fact, a carbonated alkali; potash may be rendered sensible in this way in solutions of the sugar of the cane, of beet root, of grapes, and of milk, and also in gum arabic or *tragacanth*, and in starch.

10. *New Colouring Matter.*

MM. Pelletier and Caventau have made some experiments on the green matter of the leaves of plants, from which it appears to be a peculiar substance. They obtained it by pressing and then washing in water the substance of many leaves, and afterwards treating it with alcohol; a matter was dissolved out, which when separated by evaporation, and purified by rewashing in hot water, appeared as a deep green resinous substance. It dissolves entirely in alchol, ether, oils or alkalies; it is not altered by exposure to air; it is softened by heat, but does not melt; it

burns with flame and leaves a bulky coal. Hot water slightly dissolves it; acetic acid is the only acid that dissolve it in great quantity. If an earthy or metallic salt be mixed with the alcoholic solution, and then an alkuli or a subcarbonate be added, the oxide or earth is thrown down in combination with much of the green substance, forming a lake. These lakes appear moderately permanent when exposed to the air. In consequence of these properties, the above named chemists have distinguished this body from the other proximate principles of vegetables, and have proposed the name *Chlorophyle* for it.

11. *Iodine.*

Iodine dissolves in the sulphuret of carbon, a very small quantity of it (one thousandeth part) giving to that fluid a fine amethystine tint. M. Lampadeus has in consequence recommended this substance as a test for iodine; but it can scarcely be used for that purpose, from the scarcity of the re-agent, and its want of action on iodine in combination.

Iodine dissolves, producing a similar colour in what has been called chloric ether, or the triple compound of chlorine, charcoal and hydrogen. If ether, alcolol or water be added to these solutions, the fine amethystine or violet tint immediately disappears, giving place to a reddish brown. If the solution be exposed to the air, the solvent evaporates, and the iodine remains behind crystallized.

12. *Platinum.*

M. Pretchel, Director of the Polytecnique Institution of Vienna, has succeeded (it is said) in fusing masses of platinum in crucibles by the heat of a furnace; but from the description given of its properties after the process, there is reason to suppose, that it has in some way become impure. Its specific gravity is given as 17.2 only; and when heated and hammered it breaks with a granular fracture, like cast iron, which is accounted for by a supposed crystallization. Further, crude platinum cannot be fused in the furnace which effects these changes in pure platinum.

13. *Indelible Ink.*

The purple precipitate of Cassius is recommended in the

Italian Journals as an indelible ink, much superior to that of silver. That part of the linen on which is to be the writing, is first to be moistened with a solution of recently made muriate of tin, and when dry, to be written on with solution of gold, and then washed in water. The writing, which will become black, is not at all affected by washing, and with great difficulty by other agents, and not before the cloth is destroyed.

14. *Mutual precipitation of Tin and Lead.*

M. Fischer has lately shewn the power possessed by tin and lead, of reciprocally precipitating their salts in the metallic state. If metallic lead be placed in the acid acetate of tin, it precipitates all the tin; and if tin be placed in the acid acetate of lead, it precipitates lead, but only in part. The action will not commence on either side unless there be a little excess of acid; but once began with the tin, it will go on when neutral.

15. *Deoxidation of Indigo.*

The solution of indigo in sulphuric acid may be readily deoxidized and rendered colourless, by throwing into it a few filings of iron or zinc; the hydrogen produced, effects the change, and much more readily from being in the nascent state. If this decoloured solution, or rather the solution with a pale tint, be exposed to the air, it immediately resumes its blue colour. T. Holt.—*Annales de Chimie, &c.*

16. *Soda Alum.*

M. Zellner has succeeded in making an alum with soda; it crystallizes, effloresces slightly in the air, and is soluble in twice its weight of water. Its composition is given as alumine, 16.5; soda, 9.83; sulphuric acid, 37.5, with 5.1 of water.

17. *Moiree Metallique.*

The Marquis Ridolfi has suggested a modification of this ornamental material, which consists in sketching flowers, figures, or other designs, upon the tin plates, with pale or coloured varnishes, before they are dipped in the acid bath. The figures are, of course, left with the original appearance of the

tin, and may be brought out in great perfection; or they may be made by laying on leaf gold or silver, the latter metals with the varnish defending the surface of the tin covered with them from the acid.

18. *On the Construction of Fire-places. By* N. Arnott, M. D.

During my attendance lately in some cases of pulmonary disease, while considering how best to attain the important objects of uniformity of temperature, and the prevention of draughts or currents of air, in the apartments to which the patients chiefly confined themselves, a simple means occurred to me, which, on trial, perfectly succeeded. It is an addition easily made to any fire-place; and as its uses are important to the health and comfort of all the inhabitants of cold climates, I am happy to suggest it to the public.

It is simply a glazed metal frame work, or window, placed before the fire, and coming in contact with the chimney-piece and hearth all round, so as perfectly to cut off communication between the room and the fire-place; and the fire is fed with air brought by a tube from without.

Completely to understand the effect of it, it may be remarked, that of the heat produced by the combustion of fuel in a common fire-place, a part radiates into the room as the light does, and the remainder ascends the chimney with the smoke. That which finds its way into the room, contrary to common apprehension, is probably not more than a fourth part of the whole heat produced; but even less than this would be sufficient to preserve in the room the desired temperature, could it be all retained. The great current of air, however, in the chimney, carries this heat again quickly with it, (for it is the warm air of the room passing away,) and a chimney of the ordinary proportion, and with the ordinary velocity of the smoke, will allow the whole air of the apartment to pass out by it in less than half an hour.

The glazed frame then, described above, will prevent, it is evident, the heat when once received into the room, from again escaping from it, as it now does, with the air ascending

in the chimney; and although the glass is some obstacle to the radiation of the heat from the fire in the first instance, the disadvantage is much more than compensated by its retaining agency afterwards.

One of our rooms, as now constructed and heated, may be compared to a vessel of water of similar shape, with a hole near its bottom, through which the water is constantly running off, while an attempt is making, at the same time, to warm its contents by heat radiating inwards, from the hole and around it. The hottest water would always get out first, being nearest the opening from whence the heat came; and to keep the vessel full, this would be replaced by fresh cold water, entering by one or more openings in the circumference. It would require a powerful heat indeed, to raise much the temperature of such a vessel; and it is evident, that no degree of heat so admitted, could warm the contents uniformly.

It may be supposed that I have underrated the proportion of caloric which radiates from a fire into the room, compared with that which ascends the chimney, in calling the former only a fourth part of the whole produced; but the following considerations, without new experiment, may probably be accounted decisive of the question. Mr. Leslie, in his experiments on heat, found that a metallic vessel of water, of medium temperature, suspended in the air, lost about half its caloric by radiation, and half by contact with the air. At a higher temperature, however, on account of the increased velocity of the air, caused by its greater expansion, or in an artificial current of air, without higher temperature, it lost much more by contact than by radiation. Now, in a fire are found the two circumstances of extreme heat and great velocity, and to these is added a third, of much greater importance than either, viz. the surface of contact being exceedingly increased by the air passing between the pieces of coal, while the surface of radiation, viz. the external surface, remains the same.

It is a thing not sufficiently adverted to in the management of our fires, that the heat given into the room, is proportioned rather to the extent of burning surface presented towards the

room, than to the depth of the fire, the intensity of the heat backwards, and the quantity of the fuel consumed. I have been trying experiments, with a view to ascertain the propor-portions exactly; of which, however, I have not as yet had time to prepare an account for publication; but as the general result, I may state, that a tile, or sheet of iron, laid on the back part of the fire, so as to cover it closely, and to prevent combustion except in front, rather increases than diminishes the radiation of heat towards the apartment, and much less fuel is consumed.

In constructing the glass frame proposed, a part must be made to open, to allow the putting on of coal, and stirring of the fire.—The air to feed the fire, may come from an opening in the external wall, by a tube concealed behind the wainscoat. In the case where it was first tried, a useless chimney happened to pass by the side of the fire place, and a brick taken from between them, gave admittance to the air. In whatever way the object be accomplished, we should have it in our power to admit more or less air, so as to regulate the combustion at will, as in the common furnace. The room may be ventilated by a small opening near the cieling, either into the chimney or into the stair-case, to be made to open and close too, to the degree required. The heated air tubes now commonly connected with fire places, are peculiarly adapted to this plan, and with it, produce the greatest possible saving of fuel; and the method of supplying coal to the fire from below it, or in any other way that secures the combustion of the inflammable gases contained in the coal, which I hope may soon become general, has the same utility here as in other cases.

The advantages of the plan may be shortly enumerated as follows:

1. The nearly perfect uniformity of temperature in the air throughout the room, rendering it a matter of indifference in what part the company sits.

2. The total prevention of draughts or currents of air, which are inevitable in our rooms, as now warmed, because the fire must be supplied with air from the doors or windows. It is

is almost needless to mention, that a great proportion of the winter diseases of this climate are occasioned by these currents, acting partially on our heated bodies.

3. The saving of fuel. Less than half the usual quantity will generally be found to keep the apartment in the most comfortable state.

4. The raising the temperature of the air of the house generally. For were all the chimnies thus closed with respect to the apartments, although fires were lighted but in a few, any degree of heat once generated in the house, would be long retained.

5. It completely prevents smoke or dust, a circumstance which alone renders it extremely valuable in many cases; and with it there is no danger of fire.

In these particulars are comprehended all the advantages of the close stoves of Continental Europe, so superior to ours in economy, and in the degree and uniformity of the temperature produced, with what many will call a very great additional one, that of seeing the fire; and it avoids their disadvantage, of giving a burnt or sulphury odour to the air of the apartment. It should not be forgotten, that at a very moderate expense the change described may be made on all our common fire places.

Bedford Square, Dec. 1818. N. ARNOTT.

19. *American Water Burner.*

An apparatus called the American Water Burner, has been invented by Mr. Morcy of New Hampshire. It is a rough blow pipe; but is applicable in many cases in place of a furnace. Tar is intimately mixed with steam, and made to issue from a small jet, in the manner of an eölipile, and the stream of matter being ignited, produces a flame of great size and intensity. It appears that the water is partly decomposed towards the middle of the jet, and that the heat is thus increased, by increasing the quantity of active agents. But whatever the exact effect, the water is found to be useful in preventing the formation of smoke, and increasing the combustion.

§ 2. Meteorology, Magnetism, &c.

1. *Mock Suns.*

Extract from a Pamphlet entitled "Somewhat written by occasion of Three Sunne's, seene at Tregnie, in Cornewall, the 22d of December last; with other memorable occurrents in other places. Imprinted 1622." *20 pages, small 4to.*

"Since this strange apparition, namely, upon the tenth of January last, there happened in Devonshire, yet not farre from the other place, being on the edge of Cornwalle, another wonder, which did as much affright the eares of men, as this did their eyes: for in the afternoone of that day, being the Thursday after Twelfth day, there were heard in the aire, unusuall cracks or claps of thunder, resembling in all points the sound of many drums together, sometimes beating charges, sometimes retreats, sometimes marches, and all other points of warre: which after it had continued a good time, it seemed that the same thunder did most lively expresse many volleyes of small-shot, and afterward the like volleyes of ordnance, with so great and yet so distinct noyse, that many of them who dwelt neere the sea, went toward the shore to see what it might meane, as verily supposing there had beene some sea fight neere upon that coast. These severall fearfull noyses were againe and againe renewed in the same order, till at length with an horrible and extraordinary cracke of thunder, there fell in a ground of one Robert Pierce, where there were divers worke-men planting apple-trees, (which ground lay neere the house of one Master George Chidley) a thunder-bolt, if I may so call it, being a stone of three foot and an halfe in length, of two foot and an halfe in bredth, and one foot and an half in thicknesse, the substance whereof was in hardnesse and colour not muck unlike a flint, as appeares by many peices thereof, which are shewed up and downe by many credible and honest gentlemen, who, with their own hands, brake them off from the maine stone. After the fall of this stone, which with the weight thereof was cleane buried in the ground above

a yard deepe, the thunder ceased, and people began as much to wonder at that which they now saw, as they had lately done at that, which with so much feare and amazement they had heard." P. 13, and 14.

2. *Aerolite.*

The Russian papers describe an aerolite which fell at the village of Slobodka, in the government of Smolensko, on the 29th of July (O. S.) The stone weighed seven pounds, had a rough surface, and was covered on the surface with a brown crust, through which in places appears the substance of the stone itself, of a gray colour, and sprinkled with spots of a metallic appearance. It descended with such violence as to penetrate nine werschoks (1,31 foot) into the ground.

3. *Meteoric Iron in North America.*

The northern *Esquimaux* lately visited by Captain Ross, were observed to employ a variety of implements of iron, and upon inquiry being made concerning its source by Captain Sabine, he ascertained that it was procured from the mountains about 30 miles from the coast. The natives described the existence of two large masses containing it. The one was represented as nearly pure iron, and they had been unable to do more than detach small fragments of it. The other, they said, was a stone, of which they could break fragments, which contained small globules of iron, and which they hammered out between two stones, and thus formed them into flat pieces, about the size of half a sixpence, and which let into a bone handle, side by side, form the edges of their knives. It immediately occurred to Captain Sabine that this might be meteoric iron, but the subject was not further attended to till specimens of the knives reached Sir Joseph Banks, by whose desire Mr. Brande examined the iron, and found in it more than three per cent. of *Nickel.* This, with the uncommon appearance of the metal, which was perfectly free from rust, and had the peculiar silvery whiteness of meteoric iron, puts the source of the specimens alluded to out of all doubt. The one mass is probably entirely iron, and too hard and intractable for their management; the other appears to be a *meteoric stone,* containing pieces of iron, which they succeed in removing, and extending upon a stone anvil.

Some experiments upon the power of an alloy of iron with nickel to resist rust, and upon its fitness for delicate cutting instruments, are now in progress, with the results of which we shall in due time acquaint our readers.

4. *Earthquakes.*

Early in the morning of the last day of May, a severe earthquake was felt at Mexico, which did much injury to the city. Many of the public buildings suffered materially. A number of the arches of the aqueduct of Santa Fé were rent and discharged quantities of water, and the aqueduct of Belen and nine bridges were greatly injured. The hospitals, military quarters, cathedrals, churches, and other large buildings did not escape the effects of the shock.

A dreadful shock of an earthquake was felt in Iceland in October, accompanied with subterranean noises and horrid crashes, at the close of which an eruption from Mount Hecla commenced.

An earthquake, sufficiently powerful to shake the windows and furniture of houses, was felt on the 11th of October, along the base of the mountain north of Quebec.

A shock of an earthquake was felt on the 31st of October, at Dalton, in Low Furness (Lancashire). A shock was felt near the same place about a year ago; and it is said that such convulsions are not rare in the line of country which extends along the western coast from Lancashire to Ayrshire in Scotland.

A smart shock of an earthquake was felt at Inverness, and to some distance round the town, at about 20 minutes past 12 o'clock, on the night of Tuesday November 10. It was felt with great violence along the banks of Loch Ness. The motion continued nearly three seconds, and was accompanied by a noise like thunder. Lighter shocks were also felt on the evening of Tuesday, and at four in the morning of Wednesday.

A slight shock of an earthquake was felt at Bangor, on Monday Dec. 7, about nine o'clock in the morning. It was much more sensible in the neighbourhood of Penter, where it was described as if the earth sank nearly a yard from under the feet.

5. *Temperature below the Earth's surface.*

There are some curious observations made by Mr. Lean, inserted in the Philosophical Magazine, upon the increase of temperature in descending into the earth, and they shew this increase to go on to the depth of 200 fathoms, the lowest situation at which the temperature was taken; for instance, observed in December 1815, at the surface, and at successive depths, increasing by 20 fathoms, the temperatures were as follows: 50°, 57°, 61°, 63°,5, 64°, 66°, 70°, 72°, 70°, 74°. 78°.—The temperature taken in the air in summer and winter varied a few degrees, even to the lowest depths, but always increased on descending. It was probably also affected by the workmen, &c. but by immersing the thermometer into streams of water issuing from the sides of the shafts and galleries, it was shewn that an effect was produced independent of that cause. The water at moderate depths was cooler than the air, but at lower situations became as warm; at 100, it was 64°,air 66°; at 120 68°, air 70°—at 140, 72°, air 72°—at 200, 78°, air 78° also.

6. *Ice Islands.*

By Demerara papers, of October 24, it appears that ice islands have been seen as far south as the West Indies. A very extensive one was observed in the neighbourhood of the Bahama Islands, which gave rise to a great sensation.

7. *Theory of Terrestrial Magnetism.*

M. Hansten, Professor of Astronomy at Christiana, has lately published the result of some observations on the variation of the compass. This subject has been his study since 1807, and he finds reason to conclude that the earth has four magnetic poles, which belong to two magnetic axes, forming angles of from 28° to 30° with the axis of the earth. The arctic pole of one of the axes he places very near Hudson's Bay, and its southern pole in the Indian ocean below New Holland. The arctic pole of the other is to the north of Siberia, near Nova Zembla, and its south

pole in the great South Sea, a little to the East of Terra del Fuego. These magnetic axes are supposed to change their position every year, and thus cause the variation observed in our instruments.

III. Natural History.

§ Zoology, Botany, Mineralogy, &c.

1. *Cicada Septendecim.*

Royal Crescent, Bath, Dec. 7, 1818.

Sir,

As there appears to be a mistake in the account of "Locusts in the United States," published in the last Number of the Journal of Science and the Arts, I take the liberty of sending you a few particulars relating to these extraordinary insects, specimens having been kindly communicated to me last winter, by my friend Robert Barclay, Esq. of Bury Hill, Surrey. It is not a locust, but a cicada, and there is a good figure of it, and likewise of a twig lacerated by the female, in depositing her ova, in vol. 54 of the Philosophical Transactions, with observations upon its history, by Peter Collinson, Esq. He says, "the cicada is seen annually in Pensylvania; but at certain periods of fourteen or fifteen years distance. they come forth in such great swarms, that people have given them the name of locusts." It is probable from what follows, that there is some error in the periods of their appearance, as stated by Mr. Collinson. In the 12th edition of the Systema Naturæ, the insect is described by Linnæus under the name of *Cicada Septendecim.* Linnæus appears to have derived his information chiefly from one of his travelling pupils (Kalm), by whom an account of it was published in the Stockholm Transactions for 1756; but he likewise refers to Mr. Collinson's Paper in the Phil. Trans. for 1765, though erroneously, for it will be found in the Transactions of the preceding year, viz. 1764. In the communications which follow, from the Hon. Judge Peters, and Myers Fisher, Esq. the period of seventeen years is established, so that there seems to be no doubt of Mr.

Collinson's inaccuracy in this particular. Indeed the period mentioned by him, viz. fourteen or fifteen years, implies doubt or inexactness.

Extract of a Letter from the Hon. Judge Peters, of Belmont' Pensylvania, to Robert Barclay, Esq. Bury Hill, Surrey. Dated 6th June, 1817.

"This is our *locust* year. They arrive regularly every seventeen years. They injure the tender shoots of trees, plants, &c. by depositing their eggs more than by feeding; in fact, we do not perceive them to be voracious; some think they eat nothing, but live on the air, and are born only to propagate and die. The earth is perforated like a riddle when they rise out of it. One of your Spa-fields meetings can give you a faint idea of their incessant and unmusical cheering and noise. If Hogarth had known these locusts, he would have placed them about the ears of his enraged musician. Knife-grinders, ballad singers, &c. would have been lost in their din. The locusts so destructive in some countries, must be a different species from our intrusive visitors."

Extract of a Letter from Myers Fisher, Esq. of Ury, near Philadelphia, to the Editor of the United States Gazette, April 12, 1817.

"Having observed several paragraphs in different newspapers of this city, mentioning the expectations of a visit from the locusts in the present year, and expressing some curiosity to know more about them, I inclose the following for publication, if it be thought worthy of so much space as it will occupy in your Paper. This insect is miscalled in this country, and by a name which generally inspires terror from the ravages which the locustæ or grylli have committed in Asia and Africa, from the earliest records of history, to the most recent publications, from Moses to Captain Riley's late narrative of his travels. It is called by Linnæus, in his Systema Naturæ, Cicada Septendecim. It is perfectly harmless to the vegetable creation, and useful to the farmer in affording

nourishment to his poultry and swine, for two or three months of the scarcest season of the year. It inhabits the bowels of the earth, for sixteen years of its life, in the shape of a grub or many-legged worm, visits the air in the seventeenth, to copulate and continue its species, and perishes as food for various terrestrial and volatile creatures useful to man. It is said to have been found at the distance of more than twenty feet below the surface of the earth in digging wells: I can speak with certainty of the fact as to ten feet. I have been acquainted with it during three of its former periods, in 1766, in 1783, and 1800, in the vicinity of Philadelphia, and in the year 1809, beyond the Blue Mountains. It is believed to have the same length of duration in different parts of this very extensive continent, and may perhaps appear in some part of it every year; or rather, there is reason to believe, that they appear in every year in some part or other of the United States, with the complete period of seventeen years between every local appearance."

I have only to add, that the specimens sent to Mr. Barclay, by the Hon. Judge Peters, and communicated to me by the former, agree perfectly with the character of *C. Septendecim*, as given by Linnæus, and afford proof, if any were wanting, of the excellence of his descriptions. This species is about two-thirds as large as the European cicada, *C. Plebeia*. It is equally noisy, but whether less or more musical, I have no means of determining; the ancients, I believe, differed concerning the sounds emitted by these cicada, some praising them as musical, while others speak of them as stridulous and disagreeable.

I am, Sir, your obedient servant,

J. F. DAVIS, M. D.

2. *Fascinating Power of Serpents.*

Major Alexander Garden, of South Carolina, has, in a Paper read to the New York Historical Society, attributed the supposed power of fascination possessed by serpents, to a vapour which they can spread around them, and to objects at a little

distance, at pleasure. He first reduces the exaggerated idea which has been entertained of this power, and then adduces instances where the effect of a sickening and stupifying vapour have been perceived to issue from the animal. A negro is mentioned, who, from a very peculiar acuteness in smell, could discover the rattle-snake at a distance of 200 feet, when in the exercise of this power; and on following this indication, always found some animal suffering from its influence.

3. *Lizard embedded in Coal.*

"This animal, preserved in spirits, is now in the possession of Mr. James Scholes, engineer to that colliery (Mr. Fenton's colliery, near Wakefield). It is about five inches long; its back of a dark brown colour, and appears rough and scaly; its sides of a lighter colour, and spotted with yellow; the belly yellow, streaked with bands of the same colour as the back. Mr. S. related to me the following circumstances of its being found. In August last, they were sinking a new pit or shaft, and after passing through measures of stone, gray bind, and blue stone, and some thin beds of coal, to the depth of 150 yards, they came upon that intended to be worked, which is about four feet thick. When they had excavated about three inches of it, one of the miners (as he supposed) struck his pick, or mattock, into a crevice, and shattered the coal around into small pieces; he then discovered the animal in question, and immediately carried it to Mr. S. It continued very brisk and lively for about ten minutes, then drooped and died. About four inches above the coal in which the animal was found, numbers of muscle-shells, in a fossil state, lie scattered in a loose gray earth." Phil. Mag. 52, p. 377.

4. *Tea Plant.*

It appears from the *Moniteur* paper, that the French are endeavouring, and with some success, to naturalize the tea plant in their country, and collect it, and apply its produce to the usual purpose. It was first introduced by a Russian, in 1814. "There are already 300 stocks, which it is easy to multiply. This tea has received the approbation of the king's

physicians, and the first naturalists in France. The plants are to be sold by subscription."

5. *Haüyene.*

M. Necker, in examining the primitive limestone of the isle of Tyree, found a mineral which resembled very nearly the Hauyene of mineralogists, and which, if really that substance, will be the first known instance of its occurring in other than rocks of supposed volcanic origin. Its colour was pure sky blue, sometimes slightly green; lustre-vitreous, shining. It was translucent; of a conchoidal fracture; hard enough to scratch glass, and in rounded grains. It did not melt before the blow pipe, but dissolved in acids. It occurs in very minute grains in the masses of felspar, mica, sahlite, and augite, which are embedded in a primitive limestone, contained in the gneiss, west of the form of Balephetrech in Tiree.

6. *Prase.*

Dr. Mac Culloch has recently discovered this mineral in Scotland, forming veins in a gneiss, which contains actinolite schist.

7. *Remarkable Fossil.*

At Pennicuick, about ten miles from Edinburgh, there is a remarkable fossil tree on the banks of the river North Esk. The strata here are argillaceous schist, and contain coal at a very little distance: the surface however is covered with an alluvial deposit. From out of this rock, on the edge of the river, rises the trunk of a very large tree, to the height of several feet above the earth, and the roots penetrate the soil in a great number of directions. It is about four feet in diameter at the base, and appears to have grown in its present situation. Now it is a lapideous mass, and what organised matter there is remaining on its surface, is in the state of coal. It is split and divided in several places, in a transverse direction, probably from the action of freezing water.

8. *Native Platinum.*

A singular mass of native platinum is described as having been found in South America, by a negro, who worked in the

gold mine of Don Ignacio Obertado. These mines are in the Quebrada de Apotó, in the province of Notiva, in the government of Chocó, and the piece of platinum was found near it in 1814. It has since been presented to the King of Spain, and is now in the Royal Museum at Madrid.

Its large diameter is two inches four lines and a half, and its small diameter two inches. Its height is four inches and four lines. Its weight is one pound nine ounces and a drachm. Its colour that of native silver. Its surface rough and slightly spotted with iron ochre. The negro who found it supposing it to contain gold, tried to fracture it, but could only make a dent in the metal. The Spaniards term it *Pepeta*, signifying water-worn and not *in situ*.

Care has been taken by the Spaniards to ascertain the fact of its being platinum.

§ 2. Medicine, &c.

1. *Prize Questions, Medicine.*

1. The medical circle of Paris (Academy of Medicine) have given as a prize subject, " To determine the influence of Pathological Anatomy (morbid anatomy), on the progress of medicine in general, and particularly on the diagnosis and treatment of internal diseases. The prize a gold medal of 300 francs value, to be decreed at an extraordinary public sitting, which will take place in October 1819. The memoirs written in French or Latin, to be sent before August 1819, to M. le Dr. Chordel, Secrétaire générale du Cercle Medical, Rue Casette, Paris.

---

2. The Society of Medecine of Marseilles have proposed as the subject for dissertation for 1819, the following questions:

1. " What are the diseases of the Uterus, which are liable to be confounded with cancer and ulceration of that organ?"

2. " What are the characteristics by which they may be decidedly distinguished?"

3. " What are the curative or the palliative measures that experience has proved to be most efficacious?"

It is requested that chemical observations and examinations after death, be the basis of the observations made. The

memoirs to be written in French or Latin, and sent to M. Trucy, Secretary to the Society, before July 1819. The prize a gold medal of 300 francs value.

---

3. The Royal Medical Society of Bordeaux has given as a subject, "What are the results of too rapid growth?" "What are the means adapted to moderate its progress, if it become injurious, and to remedy the accidents which ensue from it?" The memoirs to contain positive facts, supported by practical medecine, and not the mere developement of hypothesis; to be written in French or Latin, and sent to the Secretary, before July 1819. The premium 300 francs.

---

4. The Society of Sciences of Haarlem have proposed the following questions for consideration previous to January 1, 1820.

1. "How far has it been demonstrated that the fumigations by chlorine, as directed by Guyton, have prevented the spreading of contagious maladies? What are the contagious maladies in which the effect of this gas deserves to be tried? and what ought to be observed in such experiments? Is there any reason to expect a more salutary effect, in the prevention of contagion from any other means hitherto employed or proposed?

2. What are we to regard as distinctly proved in respect of the gastric juice of the human body, and its influence in the digestion of food? Is its existence sufficiently proved by the experiments of Spallanzani and Senebier? or has it been rendered doubtful by the experiments of Montègre? What is it that comparative anatomy, and principally the opening of the stomach of animals killed; either after fasting, or in a short time after having taken food, have rendered probable in this respect? And in the case of the existence of the gastric juice in the human body, being regarded as a fact perfectly established, what ought we to avoid in order not to impair its effect in the process of digestion?

The prize for the best answer is a gold medal or 150 florins.

5. In consequence of the gift of a sum of money, by an anonymous person, for the foundation of a prize in physiology, the Royal Academy of Sciences of Paris have announced that

a gold medal of 440 francs value, will be given to the author of that printed work, or manuscript, sent to them before the 1st of December 1819, which shall appear to have contributed most to the progress of experimental physiology: and their decision will be announced early in 1820.

2. Change of the Colour of the Skin.

A very particular account of this phenomenon has been published by Dr. Emery Bissel, of Clinton, New York, in the Transactions of the Medico-Physical Society. It occurred in a man of the Brotherton tribe of Indians, who is now ninety years of age, and has gradually been becoming white for the last thirty years. The first appearance of this change was soon after an attack of acute rheumatism, in a small white patch near the pit of the stomach, and shortly after other spots appeared of the same colour, and gradually increased in size. He was at first alarmed, and endeavoured to remove them by remedies, but produced no effect, and soon desisted, and the change has continued going on irregularly ever since, the original colour remaining only on the forehead, and fore part of the face and neck, with a few small patches on the arm. The skin which has become white, is of a fine clear tint, and has nothing of a dull earthy appearance, nor of the livid hue observed in Albinos. It is more delicate to sensations of heat and cold than before, and likewise very tender, for the parts bleed much when cut or lacerated, and heal with difficulty; the perspiration is rather less than in the other parts. The man affirms he has never suffered under any cutaneous disease, except the itch, and that but twice, and also that he was a very dark Indian.

3. Remedy for the Plague.

There have been several accounts received, though most of them uncertain, respecting the efficacy of vaccination in stopping the progress of the plague. M. Aubin, Physician, at Constantinople, and M. Laford, Physician, at Salonichi, are said to affirm that it is a certain protection: of 6000 persons vaccinated at Constantinople, not one caught the infection of the plague, and the Armenians are described as being entirely free from it in consequence of their care on this point.

IV. General Literature.

1. *Prize Question, Miscellanea.*

The Royal Academy of Sciences, &c. of Toulouse, have proposed the following subjects.

For 1819, the same as that for 1816, namely, to determine the effects produced on a current of water by the construction of an obstacle less raised than the edges of the canal, and to give formulæ to express the effects. The prize 1000 francs.

For 1820. What has been the state of science, literature, and the fine arts, from the commencement of the eighth century to the end of the eighteenth century. The prize 500 francs.

For 1821. The following questions on the stratification of mineral masses: 1. To ascertain the particular circumstances presented by the stratification of mineral masses, both in the form of the layers, and in their direction and inclination. 2. To determine, on positive and well authenticated facts, the general and particular laws, to which the stratification of mineral masses is subjected. 3. To describe, according to the principles generally admitted in natural philosophy, the cause of stratification, and its laws.

The last question is only accessory, that to which the prize will be adjudged is the second. The value of the prize is 500 francs. The papers, written in Latin or French, are to be sent in before the 1st of May of the year to which the question belong.

2. *Leonardo da Vinci.*

The following observations of Leonardo da Vinci are curious and interesting, not only in themselves, but for their accordance in part with some modern theories of geology.

"Vallies are continually becoming broader, and slowly "diminishing in depth; for they receive the rain from all the "surrounding country, as well as those substances, which, in "greater or less quantity, the rivers continually carry away. "The ruins left by the mountains on the places they formerly "occupied, close the mouths of the high vallies, and cause "lakes, which are the sources of new fountains and rivers in

"other situations. All heavy substances tend to descend; "and elevated things will not remain in their high situations, "but gradually sink to the lower parts: and thus in the pro- "gress of time the world will become spherical, and conse- "quently be entirely covered with water." *Giornale di Physica, Dec.* 2, *tome* i. 195.

3. *Icelandic Literature.*

Icelandic literature has received, and is still receiving accessions, from the exertions of M. Lilliegren. This gentleman, who is Professor at Lund, is engaged in translating a number of Icelandic manuscripts, which are preserved in the Royal Library at Stockholm. A volume of these translations has already made its appearance, and others are very shortly expected.

4. *New Scientific Institution.*

An institution, under the name of "the Cornwall Literary and Philosophical Society," has been established in Cornwall, for the advancement and cultivation of natural and experimental philosophy, general history, biography, and the fine arts. The establishment of a Museum is also one of the objects of this Society, in which there are already great promises of success.

5. *Ancient Funeral Urn.*

In digging into one of the mountains which border on the commune of Ubbergen, in the kingdom of Holland, there was discovered on the 27th of November, at the depth of about nine feet, an urn of red earth, thirty-seven inches high, and nine in diameter at the middle, when it assumes a pointed form downward; it has a neck six inches long, and three in diameter all through; to it are two handles, corresponding in length with the neck. In this urn were enclosed ashes and human bones, which are in such preservation, that the minutest particle may be distinguished. Another small round urn, composed of the same materials, was also found, in which are ashes, which may be presumed to be those of the heart of the

deceased. It is indisputable (according to the antiquaries) that these urns proceed from the Romans, who during more than two centuries carried on war in this country.

6. *Hebrew Medal.*

Mr. Corlett, of Cork, has lately come into the possession of a very curious Hebrew medal. It is described as composed of brass, alloyed with a little silver, and appears to have been formed in a very deep die or mould, for though much worn, the letters are very legible. The inscription is in Syrio-chaldaic characters, and commemorates the Resurrection of the Redeemer Jesus, a head of whom is on the reverse. This appears to be the only brass Hebrew medal known at present; for though others have been seen, as the one discovered in the isle of Anglesea early in the last century, and the two that were seen in Rome in the time of Leo X., yet they have disappeared, and are not now known of.

7. *Ancient Coffin.*

In the field of East Chirton, called "Blake Chesters" at one time, and now Crawley, near North Shields, is a large Roman encampment or entrenchment. On the 30th of October, whilst the workmen of Collingwood main colliery were cutting for a water level, they found, in the south-west angle of this entrenchment, the remains of a human body. They were enclosed in flag stones set upon their edges, about four feet under ground, and covered over by other stones. Only a skull, and two or three other bones were found, which crumbled away on exposure to the air. Nothing else was found within the inclosure, except a little white sand.

8. *Ancient Bridge.*

[From the Dutch Papers, Zevalle, October 29.]

Between Vatte and Exloo, in the veen (a marsh,) in the district of Dienshe, a bridge has been discovered, four feet under ground, which has been uncovered for the length of a league and a half, and the end of which is not yet known. The following are some particulars. The bridge, of which more is

daily discovered, runs from the Weerdenger Sout through the Marsh, past the Haar, and the convent Ter Apel, a distance of above three full leagues; it consists principally of rough firs, of the length of twelve feet, neatly laid together; where the marsh ground is carefully taken up, no interval is to be seen between their stems, which are, on an average, three or four inches in diameter. Here and there, instead of stems, are split planks of the above length, and various thicknesses: there are no nails, and all is hewn with the axe. It is generally believed that this is the bridge of Germanicus mentioned by Tacitus, and which was laid along this place by forty Roman cohorts, on occasion of a hasty retreat fifteen years after the birth of Christ.

9. *Gold Coin.*

A gold coin of Edward III., called a rose-noble, was found in the beginning of this month on Mr. B. Marriott's farm at Freshford. It is in good preservation.

10. *New Cod Bank.*

An immense bank, covered with cod, has been discovered lately, extending from Passa Westra, in Orkney, along the west coast of the Shetland Islands. The fishing has already been very abundant, and it is expected that employment will be given to several hundred fishing vessels on it.

11. *Cattle consumed in London.*

The consumption of sheep and lambs in London in twelve months, has been lately estimated at the number of one million sixty-two thousand seven hundred. The number of horned cattle slaughtered, at one hundred and sixty-four thousand; and by the inspectors return, it appears, that the number of horse hides produced at Leadenhall market amounted to twelve thousand nine hundred.

12. *Povisional Committee for Encouragement of Industry, &c.*

For the information of friends, the Provisional Committee for Encouragement of Industry and Reduction of Poor's-rates, has great pleasure in acquainting them that their adopted

resolution to request information, has been very successful, having the gratification of receiving perpetual communications of the greatest interest from every quarter.

For the Committee,

BENJ. WILLS, *Sec.*

King's Head, Poultry, Dec. 17, 1818.

Royal Institution.

The first Course of Lectures and Demonstrations in the Laboratory of the Royal Institution, by Mr. Brande, are now delivering. The second Course will commence early in February. See the Prospectus, page of this Volume.

The Members and Subscribers are informed that the Lectures will commence on Saturday the 30th of January, at Two o'clock precisely, when an Introductory Discourse will be delivered by Professor Brande; and that the following arrangements have been made for the season.

On Theoretic and Experimental Chemistry; by William Thomas Brande, Esq. Sec. R. S. Lond. and F. R. S. Edin. Prof. Chem. R. I.

This Course will be divided into two parts. The first will relate to the chemical history and properties of the metallic substances, and of their natural and artificial combinations. To commence on Saturday, the 30th of January, and be regularly continued on each succeeding Saturday, at Two o'clock, till the 3d of April.

The second part of the Course will comprize a view of the Chemical Physiology of Vegetable Substances, and of the properties and uses of vegetable produce. To commence after Easter.

On the application of Steam to manufacturing and other useful purposes; embracing a particular examination of the Steam Engine, and its various applications. By John Millington, Esq. Civil Engineer, Professor of Mechanics to the Royal Institution. To commence on Wednesday the 3d of February, at Two o'clock, and be regularly continued on each succeeding Wednesday at the same hour, till 31st March.

On the application of Mechanics to the purposes of Agriculture, and Husbandry. By the same. To commence after Easter.

Art. XX. Meteorological Diary for the Months of September, October, and November, 1818, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY
for September, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Tuesday	1	54	74	29,50	29,40	SE	SW
Wednesday	2	50	68	29,60	29,70	W	W
Thursday	3	51	71	29,86	29,80	W	SE
Friday	4	60	75,5	29,80	29,80	SW	SW
Saturday	5	63	71	29,82	29,75	WbS	WbS
Sunday	6	55	67	28,65	29,65	WbS	W
Monday	7	50	64	29,70	29,97	W	WbS
Tuesday	8	44	61	29 80	29,97	W	W
Wednesday	9	37	61	29,65	29,60	SW	E
Thursday	10	43	56	29,66	29,70	NW	NW
Friday	11	40	59	29,73	29,73	W	NW
Saturday	12	41	62	29,88	29,90	W	NE
Sunday	13	45	65,5	30,10	30,10	NbW	NW
Monday	14	43	67	30,10	29,92	W	W
Tuesday	15	57	61	29,70	29,54	Wb	W
Wednesday	16	42	57	29,50	29,50	WbS	WbS
Thursday	17	39	59	29,80	30,00	W	W
Friday	18	49	60	30,00	29,88	SSW	SSW
Saturday	19	53	68	29,74	29,67	SW	SW
Sunday	20	55	63	29,51	29,47	E	SE
Monday	21	50	67	29,34	29,39	SE	SE
Tuesday	22	48	65	29,50	29,50	SE	SW
Wednesday	23	39	63	29,59	29,44	SE	SE
Thursday	24	49	64	29,50	29,50	S E	SE
Friday	25	42	61,5	29,55	29,50	S E	SE
Saturday	26	52	61	29,38	29,48	SE	SE
Sunday	27	51	63	29,50	29,48	SE	SE
Monday	28	56	68	29,50	29,53	E	E
Tuesday	29	54	68,5	29,55	29,55	E	E
Wednesday	30	56	65	29,43	29,40	E	EbS

METEOROLOGICAL DIARY
for October, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Thursday	1	53	64	29,38	29,38	E	E
Friday	2	52	63	29,44	29,50	E	SE
Saturday	3	52	65	29,42	29,37	S	W
Sunday	4	50	60,5	29,40	29,36	SW	W
Monday	5	44	57	29,30	29,20	W	SW
Tuesday	6	40	56	29,18	29,27	WbS	W
Wednesday	7	38	56	29,40	29,45	W.	WbN
Thursday	8	39	56	29,68	29,70	W	W
Friday	9	36	59	29,76	29,70	NW	SW
Saturday	10	37	60	29,55	29,47	SW	SW
Sunday	11	56,5	63	29,43	29,32	WbS	SE
Monday	12	45	56	29,60	29,70	SW	SE
Tuesday	13	45	60,5	29,70	29,77	SbE	SbE
Wednesday	14	44	65	29,87	29,82	SE	SE
Thursday	15	53,5	64,5	29,82	29,80	E	EbS
Friday	16	56	63	29,85	29,90	S	SSW
Saturday	17	48	62	30,00	29,97	SW	SW
Sunday	18	51,5	61	29,84	29,84	SE	SSE
Monday	19	45	51,5	29,90	29,88	WbS	SE
Tuesday	20	46	60,5	29,95	30,02	S	SE
Wednesday	21	42	53	30,10	30,04	SE	SE
Thursday	22	47	50,5	29,93	29,90	E	E
Friday	23	44	51	29,90	30,00	E	E
Saturday	24	43,5	50	30,00	30,00	E	E
Sunday	25	44	57	30,00	29,96	NE	E
Monday	26	43	60	29,96	29,96	E	EbN
Tuesday	27	37	61	30,00	30,02	EbN	EbS
Wednesday	28	39	60	30,00	30,03	SE	SW
Thursday	29	44	57	30,12	30,19	W	WNW
Friday	30	49	56	30,19	30,10	W	S
Saturday	31	46	58	29,92	29,82	W	SW

METEOROLOGICAL DIARY

for November, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Sunday	1	47	58	29,82	29,82	W	SW
Monday	2	45	56	29,75	29,70	S	SW
Tuesday	3	48	57	29,60	29,55	SW	SbE
Wednesday	4	49	54	29,42	29,30	SE	SE
Thursday	5	50	53	29,30	29,28	SE	NE
Friday	6	50,5	55	29,27	29,31	NE	EbN
Saturday	7	48	52	29,50	29,61	NE	E
Sunday	8	32	50	28,78	29,80	EbN	NE
Monday	9	40	48	29,82	29,85	NE	E
Tuesday	10	44	47,5	29,85	29,76	NE	E
Wednesday	11	45	49	29,63	29,65	E	ESE
Thursday	12	45	48,5	29,58	29,50	SE	SE
Friday	13	42	53	29,47	29,47	E	SE
Saturday	14	44	55	29,47	29,27	SE	SW
Sunday	15	43	52	29,35	29,51	SW	SW
Monday	16	46	57	29,48	29,37	SW	WbS
Tuesday	17	40	49	29,53	29,71	WbS	W
Wednesday	18	32,5	47	29,87	29,90	W	W
Thursday	19	35	53	29,90	29,90	W	SE
Friday	20	38	47	29,80	29,73	EbS	E
Saturday	21	37	42	29,65	29,60	E	E
Sunday	22	36	45	29,60	29,60	E	E
Monday	23	35	52	29,40	29,40	SE	W
Tuesday	24	41	47	29,55	29,67	SE	W
Wednesday	25	49	48	29,91	29,97	W	S
Thursday	26	42	52	29,93	29,90	WbS	SW
Friday	27	49	54	30,18	30,20	W	WSW
Saturday	28	46	53	30,20	30,19	WSW	WSW
Sunday	29	52	55	30,19	30,13	W	W
Monday	30	48	51,5	30,09	30,03	SW	SW

Select List of New Publications during the last Three Months.

Transactions of Societies.

Transactions of the Royal Society of London, for 1818, Part II. 4to. *1l.*

Transactions of the Royal Society of Edinburgh, Vol. VIII. Part II. 4to. *1l. 5s.*

Medico-Chirurgical Transactions; with plates, Vol. IX. Part. I. 8vo. 10*s.* 6*d.*

Botany and Horticulture.

Fuci; or Coloured Figures and Descriptions of the Plants, referred by botanists to the genus Fucus. By Dawson Turner, Esq. A. M. F. L. S. No. XLV. 4to. 7*s.* 6*d.*

The Shrubbery Almanack; one sheet, 1*s.* coloured.

Chemistry and Natural Philosophy.

The elements of experimental chemistry. By William Henry, M. D. F. R. S. &c. &c. 8th edition, comprehending all the recent discoveries, with plates, 2 vol. 8vo. 1*l.* 8*s.*

An Account of the History and Present State of Galvanism. By John Bostock, M. D. F. R. S. 8vo. 7*s.*

The System of the Weather of the British Islands, discovered in 1816 and 1817; from a journal commencing in November 1802. By Lieut. Geo. Mackenzie, R. P. M. 4to. 1*l.* 1*s.*

Evening Amusements; or the Beauties of the Heavens Displayed; in which several striking appearances to be observed in various evenings in the heavens, during the year 1819, are described by William Frend, Esq. M. A. 12mo. 3*s.*

Mathematics.

Essays on the Combinatorial Analysis; showing its application to the most useful and interesting problems of algebra. By Peter Nicholson, 8vo. 16*s.*

The First Principles of Algebra, designed for the use of Students. By T. W. C. Edwards, M. A. 8vo. 6*s.* (on fine paper, 7*s.*)

A Treatise on Spherics; comprising the elements of spherical geometry, and of plane and spherical trigonometry; together with a series of trigonometrical tables. By D. Cresswell, M. A. 8vo. 7*s.*

Medicine, Anatomy, and Surgery.

A Supplement to the Pharmacopœias. By G. F. Gray, 8vo. 10*s.* 6*d.*

Practical Researches on the Nature, Cure, and Prevention of Gout. By James Johnson, 8vo. 5*s.* 6*d.*

An Account of the Small Pox, as it appeared after vaccination; including, among many cases, three which occurred in the author's own family. By Alexander Monro, M. D. with plates, 8vo. 10*s*. 6*d*.

Observations on the Extraction of the Placenta. By James Murdock, M. D. 8vo. 1*s*. 6*d*.

Pathological and Surgical Observations on Diseases of the Joints. By B. C. Brodie, F. R. S. Illustrated by plates, 8vo. 16*s*.

An Inquiry into the Influence of Situation on Pulmonary Consumption, and on the Duration of Life; illustrated by statistical reports. By J. G. Mansford, 8vo. 5*s*.

Practical Observations on the Nature and Treatment of Marasmus, and of those Disorders allied to it, which may be strictly denominated Bilious. By Joseph Ayre, M. D. 8vo. 7*s*.

Reports of the Practice in the Clinical Wards of the Royal Infirmary of Edinburgh, during the months of November and December, 1817, and January, May, June, and July, 1818. By A. Duncan, jun. M. D. F. R. S. E. 8vo. 4*s*.

Physiological and Medical Researches into the Causes, Symptoms, and Treatment of Gravel. Translated from the French of F. Magendie, M. D. Professor of Anatomy, &c. at Paris, 12mo. 3*s*. 6d.

Directions for the Treatment of Persons who have taken Poison, and those in a State of apparent Death; together with the means of detecting poisons and adulterations in wine. Translated from the French of M. P. Orfila, by R. H. Black, surgeon; with an Appendix on Suspended Animation, &c. 12mo. 5*s*.

On the Mimoses: or a Descriptive, Diagnostic, and Practical Essay on the Affections usually denominated Dyspeptic, Hypochondriac, Bilious, Nervous, Hysteric, Spasmodic, &c. By Marshall Hall, M. D. 8vo. 6*s*.

An Essay on the Disorders of Old Age, and on the means for prolonging Human Life. By Anthony Carlisle, F. R. S. &c. 8vo. second edition, with important additions, 5*s*.

TOPOGRAPHY.

The History of the City of Dublin, from the earliest accounts to the present time; with biographical notices of eminent men, and copious appendixes of its population, revenue, commerce, and literature. By the late John Warburton, Esq. deputy keeper of the records in Birmingham Tower, the late Rev. James Whitelaw, and the Rev. R. Walsh, M. R. I. A. Illustrated by numerous views, maps, &c. 2 vols. 4to. 5*l*. 5*s*. large paper, 8*l*. 8*s*.

The History of the County Palatine of Chester. By J. H. Hanshall, Parts I. to VI.

A Second Memoir on Babylon. By Claudius James Rich, Esq. with plates, royal 8vo. 8*s.*

Annals of Aberdeen, from the reign of King William the Lion, to the end of the year 1818; with an account of the city, cathedral, and university, of Old Aberdeen. By William Kennedy, Esq. Advocate, Aberdeen, 2 vols. 4to. 4*l.* 4*s.*

VOYAGES AND TRAVELS.

A Chronological History of Voyages into the Polar Regions, undertaken chiefly for the purpose of discovering a north-east, north-west, or polar passage, between the Atlantic and the Pacific, from the earliest period of Scandinavian navigation, to the departure of the recent expeditions, under the orders of Captains Ross and Buchan. By John Barrow, Esq. F. R. S.; to which are added, a Narrative of Captain Buchan's expedition into the interior of Newfoundland, and a relation of the discovery of the strait of Anian, made by Captain L. F. Maldonado, in the year 1588; with an original map of the Arctic regions, 8vo. 12*s.*

A Narrative of the Shipwreck of the Oswego, on the coast of South Barbary, and of the sufferings of the master and crew, while in bondage among the Arabs, &c. &c. By Judah Paddock, her late master, 4to. 1*l.* 5*s.*

The Tourist through Ireland; by which the traveller is directed to the objects most worthy of notice, whether of antiquity, art, science, or the picturesque, 12mo. 6*s.* with the maps coloured, 7*s.*

A Narrative of a Journey of five thousand miles, through the Eastern and Western States of America; contained in eight reports, addressed to thirty-nine English families, by whom the author was deputed, in June, 1817, to ascertain whether any, and what part of the United States would be suitable for their residence. By Henry Bradshaw Fearon, 8vo. 10*s.* 6*d.*

A Year's Residence in the United States of America. By William Cobbet. Part I. 8vo. 6*s.*

Gleanings and Remarks, collected during many months residence at Buenos Ayres, and within the upper country, with a prefatory account of the expedition from England, until the surrender of the colony of the Cape of Good Hope, under the joint command of Sir David Baird, G. C. B. K. C. and Sir Home Popham, K. C. B. By Major Alexander Gillespie, with maps, &c. 8vo. 10*s.*

A Classical Tour through Italy and Sicily, tending to illustrate some districts, which have not been described by Mr. Eustace in his Classical Tour. By Sir Richard Colt Hoare, Bart. 4to. 2*l.* 2*s.*

Recollections of Japan; comprising a particular account of

the religion, language, government, laws, and manufactures the people; with observations on the geography, climate, and population of the country. By Captain Golownin, author of a Narrative of three years captivity in Japan. 8vo. 12*s.*

SCIENTIFIC WORKS RECENTLY IMPORTED.

Histoire Naturelle des Animaux sans Vertèbres. Par M. Lamarck. Tom v. 8vo. 14*s.*

Anatomie et Physiologie du Système nerveux en général, et du Cerveau en particulier. Par le Docteur Gall. Tom. III. Partie I. 4to. Avec 12 planches en folio, 4*l.* 4*s.*

Observations sur la Phrænologie, ou la connaissance de l'homme moral et intellectuel, fondée sur les fonctions du système nerveux. Par. J. G. Spurzheim avec sept planches, 8vo. 9*s.*

Mémoires sur La Marine et les Ponts et Chaussées de France et d'Angleterre, contenant deux Relations des Voyages faits dans les Ports d'Angleterre d'Ecosse, et d'Irlande, dans les années 1816, 1817, 1818; la description de la Jetée de Plymouth, du canal Calédonien, &c. Par Charles Dupin, 8vo. 11*s.*

J. Capuron Methodica Chirurgiæ Instituta, sublevandæ tironum refricandæque peritorum memoriæ idonea, in quibus morbi cujuslibet externæ causæ, signum, atque medela, delineantur, 8vo. 2 tom. 1*l.* 4*s.*

Histoire Militaire de Piémont, par le comte Alexandre de Saluces. Ouvrage couronné par l'Academie Royale des Sciences, 8vo. 5 tom. 3*l.*

Histoire naturelle des Orangers, ornée des figures peints d'après nature. Par. M. M. Risso et Porteau. 4to. Livraison 1. avec 6 figures colories, 1*l.* 1*s.*

Encyclopédie Méthodique, lxxxvi[e] Livraison, 4to. en 2 vols. savoir, Musique, tome II. (H.—Z.) avec 114, planches gravées, et ûn Tableau; et Tableau Encyclopedique des trois règnes de la Natur, 24e. partie, Planches des Crustacées, Arachnides, et Insectes, 4*l.*

Voyage, fait dans les Années, 1816, et 1817, de New York, à la Nouvelle Orléans, et de l'Orénoque au Missisippi par les petites et grandes Antilles; contenant des details absolument nouveaux, sur ces contrées, des portraits des personnages influants dans les Etats-Unis, et des anecdotes sur les refugiés qui y sont établis. Par l'Auteur des Souvenirs des Antilles, 8vo. 2 tomes, 1*l.*

INDEX.

B.

D.

E

F.

G.

H.

I.

K.

L.

N.

O.

P.

R.

S.

T.

U.

V.

W.

London: Printed by W. Bulmer and Co., Cleveland-row, St. James's.

The following Addenda to the Article on the Ægina Marbles, page 327, has been unfortunately omitted in its proper Place.

I visited Athens with Mr. Foster, in 1811, and we had the good fortune to meet with a society of Germans, whose objects and pursuits were, like our own, chiefly directed to the remains of art. In examining the temples of Athens, with our lamented friend and companion, the Baron Haller,* some details, of singular interest and novelty, induced us to form the project of excavating the Temple of Jupiter at Ægina, for the purpose of ascertaining how far these might be found common to other remains of Grecian architecture, as well as for the general object of advancing our studies.

Mr. Linckh, of Stutgard, joined our party, and in the latter end of May, we visited the remains, and pitched our tent under the platform on which the temple stood. An ancient cave immediately under the north-east angle of it, which doubtless served the purposes of oracular and other mysteries of the god, was now converted into the habitation of our servants, and for the conveniency of our encampment.

Being at some distance from the village, we provided ourselves with arms, and a Janissary from Athens; for the Saronic gulf is so infested with the Mainiot and other pirates, as often to deter travellers from risking a visit to so remote a spot.

We however formed a strong party, and watching by turns

* This estimable and ingenious man expired at Athens, after a short illness, brought on by exposure to the malaria of the country. His virtues, and singularly amiable qualities, have rendered his loss most severe to his friends, and his death has deprived the world, in a great measure, of many valuable notices on Greek remains, which his long stay and unexampled diligence had collected. The portion of his labours in which I had a part, is, however, in my hands, in consequence of an arrangement between us at the time of our separation; but the greater part are in the possession of H. R. H. the Prince Royal of Bavaria.

with a blazing fire, for which the woody sides of the Panhellenian Mount provided very amply, we were in little apprehension of interruption. Here we passed nearly twenty days in the delightful pursuit of this excavation, and we attained completely the object of our journey, in the restoration on paper, from the admeasurements we procured, of every detail of this ancient temple.

We had not expected the extraordinary result which forms the subject of this Memoir, for it could hardly be supposed that a period of at least 2000 years could have passed, during which from the curiosity of travellers, even the hand of man, should have left these singular remains unnoticed.

The present proprietor, His Royal Highness the Prince Royal of Bavaria, has reserved the publication of the details of his Statues on an enlarged scale, and as they are now placed in the Gallery at Munich, it is hoped that they will shortly appear with all the minuteness and attention due to such interesting subjects; the casts of them, however, which by an agreement at the sale, were to be furnished to the several former proprietors, are daily expected in England. The exertions of Mr. Foster and myself to acquire the originals for this country, are well known to those acquainted with the proceeding of the Committee of the House of Commons, on the subject of the Athenian Marbles.

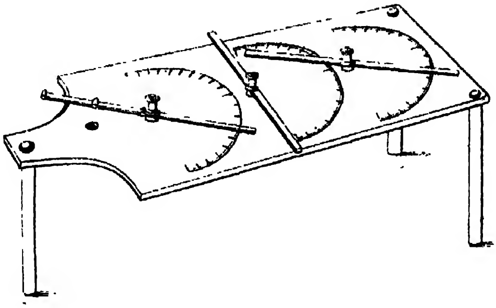


Fig 2.

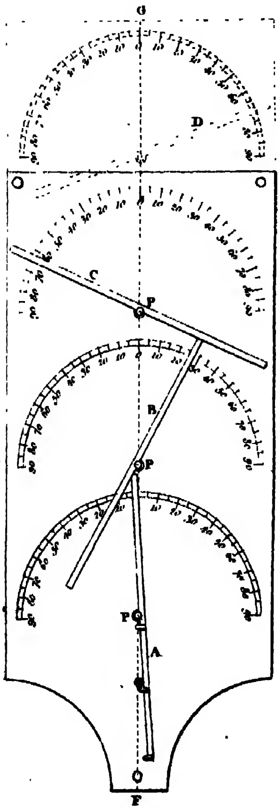
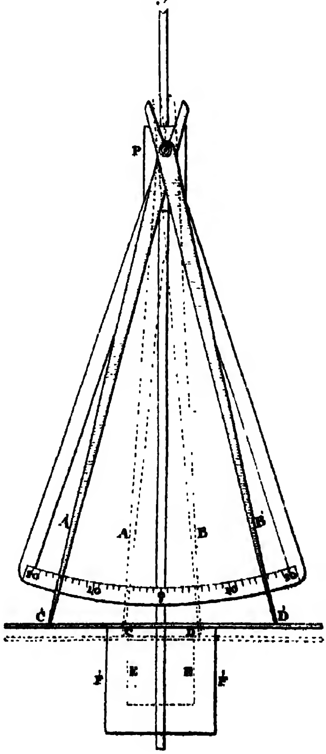


Fig. 1.



Published by John Murray, Albemarle Street, London.